Surviving and Thriving in the Face of Rising Seas

Building Resilience for Communities on the Front Lines of Climate Change

Union of Concerned Scientists

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This report and an accompanying technical appendix are available online (in PDF format) at *www.ucsusa.org/survivingandthriving*.

Designed by: Tyler Kemp-Benedict

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Tanisha Belvin (left) holds the hand of neighbor and friend "Mama Nita" LaGarde (right), while they are evacuated from the New Orleans Morial Convention Center to the Reliant Center in Houston. LaGarde, Belvin, and Belvin's grandmother managed to escape the aftermath of Hurricane Katrina without being separated—surviving the initial flood; days outdoors on a bridge, an overpass, and outside the convention center, all without adequate food or water; and finally the evacuation to Houston. Although unable to return to New Orleans, the three survivors remained together in Houston, becoming a symbol of resilience during crisis.

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On August 29, 2005, Hurricane Katrina came ashore, devastating significant swaths of the Gulf Coast states of Alabama, Mississippi, and Louisiana.

Ten years later, Katrina is most remembered for the destruction of New Orleans. In Mississippi, too, Katrina produced flood waters that reached more than six miles inland and decimated many towns and cities, through storm surge flooding of 25 to 28 feet—the equivalent of a two-and-a-half story building—above normal tide levels (NOAA 2006).

Many people who bore the brunt of this disaster lacked transportation, safe shelter, and other resources to get out of the way of the storm. In its aftermath, many did not have the financial means or insurance coverage to compensate for the loss of property and damage to homes and livelihoods. Unevenness in the post-disaster response worsened Katrina's effects. Disaster aid did not always flow first, or sufficiently, to the communities that suffered the most.

The costliest natural disaster that the United States has experienced in modern times—and serious problems in how it was handled—has cast a long shadow. As one example, local groups had to sue the U.S. Department of Housing and Urban Development (HUD) and the Mississippi governor's office to ensure that a portion of the millions of dollars in federal disaster aid was spent on public housing (Gotham 2014, Robertson 2010; Morse 2008, Eaton 2007).[1] This extreme event is a window into the human dimensions of the challenges faced by many "frontline communities," those facing the brunt of climate impacts today. It is also a harbinger of what might be in store for many more as sea level rise and storm surges worsen.

This report describes socioeconomic factors that contribute to a disproportionate burden of coastal climate impacts on African American, Latino, Native American, and other minority communities; shows that current disaster aid and preparedness policies fall short in meeting the needs of frontline communities; and lays out some promising opportunities for ensuring that our nation's investments in climate resilience are well targeted and equitably shared.[2] Our research is guided, in part, by rich discussions at a climate equity convening, co-sponsored by the National Association for the Advancement of Colored People (NAACP) and the Union of Concerned Scientists (UCS) in November 2014 (see Box 3, p. 8).

> *"After a storm, all the discussion is about property damage. It's important that recovery aid be based on how* people *were affected."*
>
> — Paul Shoemaker, associate director, Division of Environmental and Occupational Health, Boston Public Health Commission

New Orleans residents help each other during evacuation in the wake of Hurricane Katrina, with additional aid from FEMA Urban Search and Rescue task forces.
Jocelyn Augustino/FEMA

We present an analytical framework—a screening tool—that can be used to identify coastal "climate equity hotspots," communities where a combination of socioeconomic and climate risk factors creates a heightened risk to coastal flooding exacerbated by sea level rise, and which require focused policy attention. This screening tool brings together sea level rise and tidal flooding projections based on data from the National Oceanic and Atmospheric Administration (NOAA) and Climate Central, and socioeconomic data from the U.S. Census Bureau. We applied the screening tool using county-level data to create an assessment of climate and socioeconomic vulnerability for 35 coastal counties[3] spread across nine East and Gulf Coast states—Connecticut, New Jersey, Pennsylvania, Maryland, Virginia, South Carolina, Florida, Mississippi, and Louisiana (see Figure 2, p. 12). The report also includes five case studies of people and places on the front lines of worsening coastal climate risks in order to highlight some of the special issues and common challenges they face and the ways in which they are responding (see Chapter 6, p. 30).

As the challenge of climate change grows, policy solutions, resources, and further research need to be directed to where they are most needed. The equity screening methodology we present here provides a starting point for that discussion. It can also help raise awareness of challenges to building resilience, inform stakeholder dialogs about communities' choices for the future, and help policy makers as well as communities build consensus around policy and funding priorities. The data we have used are readily available. The tool is designed to be flexible and transparent. It can easily be applied to more localized data where available, expanded with additional risk factors, extended to other parts of the country, and adapted to different types of climate impacts. It can also be used over time to examine whether the relative risk profile of a community has improved with investments in resilience.

Fairness, justice, and equity go to the heart of what a true democracy like ours stands for. As a nation, we need to bring those principles to bear as we work together to confront the challenge of climate change.

As the challenge of climate change grows, policy solutions, resources, and further research need to be directed to where they are most needed.

Communities on the Front Lines of Climate Change

Sea level rise, storm surge, and coastal flooding are already costly features of life for many communities along the East and Gulf Coasts of the United States, and incidences of each are worsening with a warming climate (Office of Atmospheric Programs 2015; IPCC 2014a; Melillo, Richmond, and Yohe 2014; Spanger-Siegfried, Fitzpatrick, and Dahl 2014; The Risky Business Project 2014; Burkett and Davidson 2012; Climate Central 2012). A growing body of evidence, including from the Intergovernmental Panel on Climate Change (IPCC) and the U.S. Global Change Research Program, suggests that exposure, vulnerability, and resilience to climate impacts are closely intertwined concepts and vary with respect to communities' socioeconomic situations, including variables such as age, income, and health (see Figure 1, p. 5) (IPCC 2014a;

FEMA

New Orleans residents march in a "second line," a traditional brass band parade, commemorating the tenth anniversary of Hurricane Katrina. The parade was co-hosted by Foundation for Louisiana, an organization that works for resilience, equity, and sustainability in the area.

Melillo, Richmond, and Yohe 2014; Friend and Moensch 2013; Adger 2006; Berkes and Folke 1998).

Extreme disasters tend to bring communities' vulnerabilities into sharp relief. For example, many coastal towns and cities on the eastern seaboard faced significant storm surge flooding from Superstorm Sandy, which destroyed homes, washed out bridges and roads, and caused extended power loss. Some residents in poor health who were unable to use stairways remained trapped in high-rise public housing buildings in New York City for days. Many residents in nursing homes in Gulf Coast states were unable to evacuate ahead of Hurricane Katrina and faced harm, and even death in some cases (Dosa et al. 2010).

Communities with high numbers of elderly, very young, or low-income residents, or residents with ill health, may have fewer resources to prepare for disasters or a limited ability to relocate (Lane et al. 2013). They may have less economic or political clout to ensure they get the attention needed from disaster relief agencies, and may be more likely to have livelihoods and living conditions devastated by extreme events. In the event of a storm that brings flooding, for example, low-income families and individuals may lack transportation to get out of harm's way, may live in places that are more prone to flooding, or may live or in older, less safe housing (Kuhl et al. 2014). Many minimum wage earners on the coast work in service industries that are vulnerable to storms, such as the tourism industry. Flooding from major storms can shut down roads and bridges they use to get to work or close down their place of work, leaving people without a paycheck during a time when it is needed most. Low- and fixed-income households also may not be able to afford to pay for insurance that could help them rebuild and recover.

Master Sgt. Mark C. Olsen/New Jersey National Guard

Families with young children, the elderly, low income residents, and people with health problems are among those who may find it especially difficult to evacuate ahead of a disaster or cope with its aftermath. Pictured here, members of the New Jersey Army National Guard mobilized for Superstorm Sandy provide assistance to displaced residents at an emergency shelter in Piscataway Township, NJ.

BOX 1.

Exposure, Vulnerability, and Resilience

The IPCC has defined three terms of particular relevance for understanding the disparate impact of climate change on different communities (IPCC 2014b).

Exposure: "The presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected."

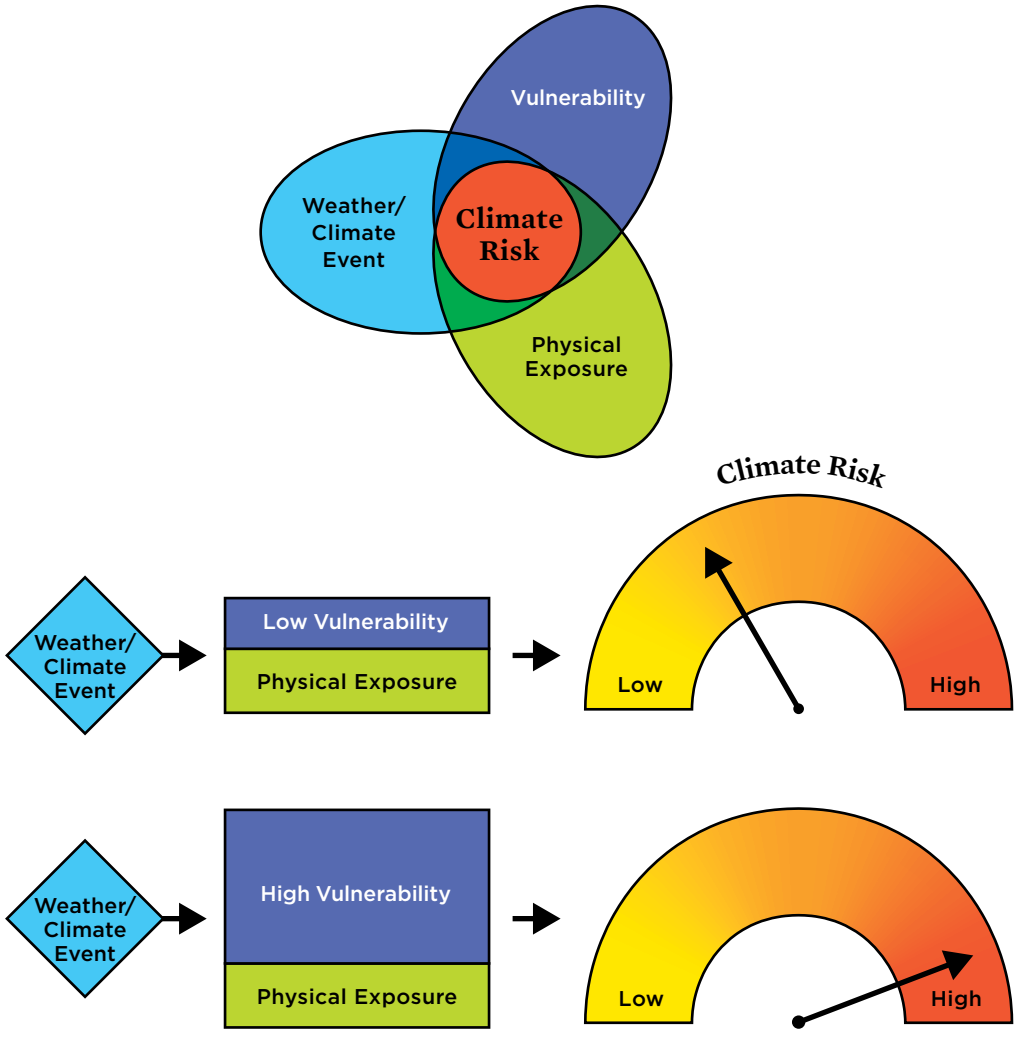
Vulnerability: "The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt."

Resilience: "The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation."

> *"There needs to be a southern initiative on climate change, one that acknowledges history and culture. We have to build policies to combat [our past] and not assume that everyone or everything is equal."*
>
> — Dr. Robert Bullard, Barbara Jordan-Mickey Leland School of Public Affairs, Texas Southern University [4]

> *"Our governor, Haley Barbour, took money to rebuild housing and turned it over to the Port of Gulfport. We have been fighting this ever since. It's very difficult to get people to believe there will be help for them...."*
>
> — Ruth Story, director of Education, Economics, Environment, Climate and Health Organization; former president, Gulfport Branch, NAACP [5]

FIGURE 1. Climate and Socioeconomic Risks Create Greater Vulnerability



The impact of extreme weather or climate events on a community depends both on physical risk factors, like coastal exposure to sea level rise, as well as on socioeconomic risk factors, such as age, poverty, or ill health, that contribute to vulnerability. Climate risks are high when exposure and vulnerability overlap (top graphic). A similar physical risk—for example, a similar amount of local sea level rise—can have a much greater impact on a community with relatively high vulnerability compared with one that has a low vulnerability (bottom graphic).

SOURCE: TOP GRAPHIC ADAPTED FROM IPCC (2012A).

BOX 2.

Housing Segregation and Climate Vulnerability

The location of many African American communities has been strongly influenced over the past 150 years by the legacy of slavery and deliberately discriminatory housing policies backed by multiple presidential administrations (Hannah-Jones 2015; Coates 2014). Past policies like mortgage "redlining" and segregated public housing greatly limited housing choice and access to fairly priced mortgages for African Americans (Coates 2014; Kerner Commission 1968).[10] As a result, even today, predominantly African American neighborhoods remain segregated in many large cities in the United States.[11] Many are located in historically undesirable parts of cities, some of which have come to be heavily polluted from industrial activities, or lie near decaying waterfronts that face encroaching tides. In some cases, homes have been built in lowlands that are vulnerable to flooding.

Often these neighborhoods lack amenities such as robust public services, good public transit options, good schools, access to healthy food, and diverse employment opportunities.[12] These amenities are all critical for economic prosperity and community well-being, and they are equally important for the resilience of communities in the face of worsening climate impacts. As we build our country's resilience, we will need to explicitly target resources to communities that have been ignored or discriminated against in the past.

> *"Low cost or affordable housing… is built in flood plains as a matter of policy, not accident."*
>
> — Vernice Miller-Travis, senior associate, SKEO Solutions[13]

This report focuses primarily on minority and low-income communities who, the research shows, face a disproportionate burden from disaster risks because they are often less able to prepare for and recover from these extreme events (Task Force on Global Climate Change 2015; IPCC 2014a; Melillo, Richmond, and Yohe 2014; Martinich et al. 2013).[6,7,8] For example, ahead of Hurricane Katrina, many financially-strapped people had a difficult time marshaling transportation to get out of harm's way to safe shelter (Zoraster 2010; Litman 2006). In areas of New Orleans flooded in the aftermath of Hurricane Katrina, African American residents outnumbered white residents by a ratio of more than two to one, and many were stranded for days in deplorable conditions (Campanella 2007).

Studies conducted in the aftermath of Superstorm Sandy show that low-income families in the New York-New Jersey area, many of whom also belong to minority communities, were among the worst affected. Three years later, they continue to face significant challenges in recovering from that storm, especially related to housing (Enterprise Community Partners 2013a; Enterprise Community Partners 2013b; Furman Center and Moelis Institute 2013).[9] A study of the African American community of Crisfield, on Maryland's Eastern Shore, in the wake of Superstorm Sandy found that residents there experienced flooding in their streets for days longer than on other streets and had great difficulty accessing food and safe housing (Miller Hesed and Paolisso 2015). Experience shows that months and years after these types of disasters, low-income communities struggle the most to recover their footing, and many find themselves permanently displaced from the places they call home.

Coping with disasters is hard for all communities, as was clear from the impact of the wide swath of destruction caused by Superstorm Sandy. Similarly, tidal flooding is affecting communities up and down the east coast, frequently disrupting daily life in places like Norfolk and Annapolis (Spanger-Siegfried, Fitzpatrick, and Dahl 2014). Communities with multiple stressors that affect their ability to cope, such as lack of economic opportunities or health concerns, face magnified challenges (Kersten et al. 2012). Those that lack access to the political and bureaucratic structures that mediate disaster response also suffer from a lack of the resources and expertise that might help them recover and

> ***Communities with multiple stressors that affect their ability to cope, such as lack of economic opportunities or health concerns, face magnified challenges from climate change.***

Bob McMillan/ FEMA.

Communities like Chalmette, LA, which are located near industrial facilities, are at risk from toxic pollution in the wake of flooding. Hurricane Katrina's massive storm surge forced an oil tank at the nearby Murphy Oil Refinery from its foundation, spilling over a million gallons of crude oil into the floodwaters and nearby canals, and affecting over 1700 homes.

> *"The current discussion around our crumbling infrastructure and [investing in] renewable energy gives us an opportunity to say, let's do it the right way without negative or unintended consequences to communities!"*
>
> — Lisa Garcia, vice president of Litigation for Healthy Communities, EarthJustice [14]

become more resilient, a plight that is worse for smaller communities (Miller Hesed and Paolisso 2015).

By many indicators, wide gaps in socioeconomic outcomes exist between African American and Latino populations and the white population in the United States.[15] These include disparities in the long-term unemployment rate, median income, wealth, health, child poverty rates, and incarceration rates (Kosanovich and Sherman 2015; DeNavas-Walt and Proctor 2014; Kochhar and Fry 2014; Sakala 2014; CDC 2013; U.S. Census Bureau 2013; Miranda et al. 2011).[16,17,18] Ample research substantiates the unequal burden of environmental hazards, such as toxic pollution, on poorer minority communities (Orum et al. 2014; Wilson et al. 2012; Bullard et al. 2007; Pace 2005; Bullard 1990; Commission for Racial Justice 1987; GAO 1983). Studies also show that African Americans have experienced disparities in disaster aid and response in the wake of extreme events such as Hurricane Katrina and the Deepwater Horizon oil spill (Bullard and Wright 2012). Environmental justice advocates work to draw attention to and push for policy changes that would limit the economic, health, and social risks that communities face (Angel 1991; Koenenn 1991; Pardo 1990).[19]

African Americans and other minorities also have a long history of facing discrimination and obstacles to full participation in the democratic process (ACLU 2015; Coates 2014; Cohen 2012). Among other things, this can hinder the inclusion of minority voices in the policy-making processes related to climate preparedness and response.

BOX 3.

Learning from an NAACP-UCS Climate Equity Convening

On November 13, 2014, UCS and the NAACP co-convened a one-day workshop in Baltimore, MD, on the equity dimensions of coastal climate impacts, such as tidal flooding, extreme precipitation, and more damaging coastal storms. The workshop drew experts from 10 East and Gulf Coast states (Massachusetts, Connecticut, New York, New Jersey, Maryland, South Carolina, Florida, Louisiana, Mississippi, and Texas), working together toward three goals: to come to a shared understanding of communities' risks and needs; to share perspectives on ways to build climate resilience by reforming disaster recovery and preparedness policies; and to begin to develop recommendations on how disparities in impacts can be addressed through climate resiliency planning and funding at the federal, state, and local levels.

Several central themes emerged from the discussions:

1. Disaster relief and recovery need to be framed differently and focused on communities most at risk and the profound ways that residents' lives may be altered by climate disasters.
2. Federal agencies (such as the Federal Emergency Management Agency [FEMA], HUD, and the U.S. Army Corps of Engineers) need to: target disaster aid and preparedness funding more equitably to build broader climate resilience around the country; build relationships of trust within a community *before* a storm hits; and engage with local community leaders to assess needs and set priorities.
3. Expanded access to affordable transportation options and healthcare is critical for building the resilience of individuals within communities.
4. U.S. infrastructure is aging and needs to be upgraded everywhere. Because much of the existing infrastructure was built during a peak period of segregation and discrimination, low-income and minority communities were disadvantaged decades ago, including in decisions about siting highways and building adequate sewage and storm-water infrastructure. Making equitable climate-resilient infrastructure investments can help protect and prepare all communities for the decades ahead.
5. Existing policies should be enforced. The enforcement of policies such as Title VI of the Civil Rights Act—which prohibits discrimination based on race, color, or national origin in programs receiving federal financial assistance—would help to address policy and funding disparities.[20]

The concerns, insights, queries, and critiques that UCS heard at this workshop deeply informed the present analysis, including our choice of sites to include and our effort to analyze future risks from sea level rise and other coastal climate impacts in the context of socioeconomic vulnerability.

Many minority communities are aware of the risks of climate change and strongly support climate action. Recent polls of Latino and African American populations show that climate change is an important issue to them and that they are already experiencing, or expect to experience, its impacts personally (NYT/Stanford/RFF 2015; Speiser and Krygsman 2014; Congressional Black Caucus Foundation 2004). More than half of the nation's Latinos live in three states: California, Florida, and Texas—all of which are already experiencing climate impacts and face serious future climate risks (Melillo, Richmond, and Yohe 2014; U.S Census Bureau 2013).

[CHAPTER 2]

Assessing a Community's Risks from Sea Level Rise and Socioeconomic Factors

As the challenge of climate change grows, policy solutions, resources, and further research need to be directed to where they are most needed. By developing methodologies to assess a community's climate and socioeconomic risk factors, we can start to identify those most at risk and prioritize policy attention and resources accordingly. This speaks directly to a recommendation from the president's State, Local, and Tribal Leaders Task Force on Climate Preparedness and Resilience to address the needs of vulnerable populations by developing "guidance and tools that consider geographic, economic, and social contexts to help identify disproportionately vulnerable populations and those most at risk to the effects of climate change" (President's Task Force 2014).

FEMA

At Bayou La Loutre in St. Bernard Parish, one of the most vulnerable climate equity hotspots, a banner demonstrates the height of the floodwaters following Hurricane Katrina.

Sea Level Rise and Flooding in Coastal Communities

Seas are rising around the world, primarily because of global warming. Warmer air temperatures are causing ocean water to warm and expand, and melting and shrinking land-based ice sheets also contribute (Levitus et al. 2012; Cazenave and Llovel 2010; Lombard et al. 2005). Since the Industrial Revolution, global sea level has risen an average of eight inches (Church and White 2011; Church et al. 2011). And the rate of global sea level rise has nearly doubled in recent years (Church and White 2011; Ablain et al. 2009; Leuliette, Nerem, and Mitchum 2004). Parts of the East and Gulf Coasts of the United States are seeing some of the highest and fastest rates of sea level rise, in part because of additional local factors like land subsidence, groundwater withdrawals, and changing ocean dynamics (Ezer et al. 2013; NOAA 2013a; Boon 2012; Sallenger, Doran, and Howd 2012; Milliken, Anderson, and Rodriguez 2008).

Flooding during high tides is already a problem in many low-lying coastal areas. As sea levels rise due to global warming, tidal flooding will become an increasingly common occurrence in many places along the East and Gulf Coasts of the United States, causing water-logged roads and bridges, damaging homes, and disrupting businesses (Spanger-Siegfried, Fitzpatrick, and Dahl 2014; Sweet et al. 2014). With growing development along our coasts, more people and property will be at risk from high tides occurring on top of elevated sea levels.

Further compounding the risks of sea level rise is the threat of storm surge riding on higher seas. Research has

shown that the impact of a storm surge is more damaging relative to impacts from sea level rise alone and can significantly increase the costs of adaptation in coastal communities (Neumann et al. 2014a; Neumann et al. 2014b). For example, one study shows that under a scenario of a 3°C rise in temperature, in Miami, FL, the costs through 2100 of adapting to the impact of sea level rise plus storm surges are projected to be approximately 2.5 times the cost of adapting to sea level rise alone (Neumann et al. 2014a).

Measuring Socioeconomic Risk

When it comes to environmental and other hazards, there are many dimensions to socioeconomic vulnerability and many ways to measure it (Office of Atmospheric Programs 2015; Lummen and Yamada 2014; Martinich et al. 2013; Cutter et al. 2009; Brooks, Adger, and Kelly 2005). In addition to quantitative metrics, qualitative assessments of socioeconomic attributes, such as strength of social networks and trust in government, can help provide a more nuanced perspective of risk that may not be readily apparent from quantitative data (Miller Hesed and Paolisso 2015; Cutter et al. 2009). "Vulnerability" as used here—in the context of climate risks—is a technical term and does not denote weakness. As such it should not be conflated with "victimhood" or lack of agency, nor should indicators of socioeconomic vulnerability be understood as *determinants* of specific outcomes. Rather, assessments of socioeconomic vulnerability can help clarify which communities and places should be prioritized in national, state, and local efforts to build resilience to climate impacts.

The Socioeconomic Vulnerability Index (SoVI) for the United States is a measure of county-level vulnerability to environmental hazards that has also been extended to the census tract level (Oxfam 2009; Cutter et al. 2009; Cutter, Boruff and Shirley 2003).[21] The index synthesizes 29 socioeconomic variables, drawn primarily from the U.S. Census Bureau, and is based on research on what factors influence a community's ability to prepare for, respond to, and recover from hazards. Factors include race, class, wealth, age, and ethnicity.

Recent research combining socioeconomic and demographic data with sea level rise and storm surge potential along the coastal United States identifies locations with heightened risk in every coastal state (Office of Atmospheric Programs 2015; Martinich et al. 2013). One study, using a census-tract level SoVI index and a model of the impacts of sea level rise on coastal property, found that a mid-range scenario for sea level rise (just over 26 inches by 2100) would impact approximately 1.6 million people, of which approximately 20 percent are among the most socially vulnerable (Martinich et al. 2013).

The scientific literature on the impacts of extreme weather on communities cites a number of factors that contribute to elevated disaster risk including: poverty, ill health, lack of mobility, employment in sectors vulnerable to disasters, impact on critical infrastructure, access to healthcare, and political or social marginalization (Miller Hesed and Paolisso 2015; Kuhl et al. 2014; Lane et al. 2013).

Other assessment tools that utilize socioeconomic and demographic variables, in conjunction with environmental factors, include the Environmental Protection Agency's (EPA's) environmental justice mapping and screening tool (EJSCREEN) and NOAA's Well-Being Assessment (EPA 2015; Dillard et al. 2013). EJSCREEN combines 12 indicators related to air and water pollution and six socioeconomic/demographic variables to create a set of 12 environmental justice indicators. The NOAA Well-Being Assessment includes nine composite indicators (each built up from several underlying variables): access to social services, satisfaction of basic needs, economic security, education, governance, health, safety, social connectedness, and environmental condition.

> ***Assessments of socioeconomic vulnerability can help clarify which communities and places should be prioritized in national, state, and local efforts to build resilience to climate impacts.***

[CHAPTER 3]

A Screening Tool for Identifying Climate Equity Hotspots

To better understand the confluence of physical and socioeconomic risk factors and to identify climate equity hotspots, UCS created a simplified screening tool for assessing a community's risks. We analyzed data for 35 coastal communities along the East and Gulf Coasts of the United States that are facing rising sea levels, increasing flood risks, and socioeconomic realities that put them at greater risk from the impacts of climate change. The 35 coastal counties in the study sample are spread among nine states along the Gulf of Mexico (Louisiana, Mississippi), around the Florida coast, and up the Atlantic coast from South Carolina to Connecticut (see Figure 2, p. 12). Our study sample, while not random, has

FEMA

Thousands of Hurricane Katrina survivors, who had been stranded in New Orleans, were evacuated by bus to the Houston Astrodome Red Cross Shelter in the days after the storm.

FIGURE 2. East and Gulf Coast Counties Analyzed

The 35 coastal counties where we applied our climate equity screening tool are spread across the East and Gulf Coasts of the United States, from Connecticut to Louisiana.

broad coverage. It includes counties with varying average incomes, sizes, and population densities, and includes many places where communities of color make up a significant share of the population. Evidence from the literature, experiences relayed at the NAACP-UCS Climate Equity Convening, and data showing higher-than-average poverty rates all suggest that climate equity concerns are likely to be relevant in many of these counties.

We created two broad measures of risk factors for the 35 counties: **a climate risk indicator** constructed using data on sea level rise and tidal flooding projections through 2045 and **a socioeconomic risk indicator** built from data on county-level per-capita income, poverty rates, race/ethnicity, and education (see Box 4; Figure 5, p. 16; and Figure 6, p. 17). In the spirit of developing an analytically tractable, easy-to-use screening tool, we used a subset of the key variables identified as important in the literature. The variables included across the two categories of risk are non-overlapping so as to avoid any double-counting of risk factors.

We constructed each risk indicator by consolidating a few key variables into a scoring metric using the technique of linear scaling (Dillard et al. 2013; Salzman 2003). (This method, commonly used in the construction of vulnerability indices, is described in more detail in Box 4, and in the online technical appendix at *www.ucsusa.org/survivingandthriving*.) The resulting relative risk indicator scores for each county allow us to examine its vulnerability from a joint climate and socioeconomic risk perspective relative to the other counties in our sample.

BOX 4.

Developing Risk Indicators

(Please see the online technical appendix at *www.ucsusa.org/survivingandthriving* for full details.)

HOW WE DEVELOPED THE CLIMATE RISK INDICATOR

To construct our climate risk indicator we used two measures: local sea level rise projections and local tidal flooding projections. To estimate these, we undertook four steps, the first three drawing on a methodology first outlined in Spanger-Siegfried, Fitzpatrick, and Dahl (2014):

1. We identified the nearest applicable tide gauge for the counties in our analysis. The tide gauges chosen were: 1) ones for which the local weather forecast office of the National Weather Service has set thresholds for water levels that are observed to cause tidal flooding, and 2) ones for which there was a 66 percent or greater correlation between the occasions when water levels at the tide gauge cross flood thresholds and the National Weather Service issues a coastal flood advisory for our county of interest. The second criterion helps to ensure that the gauge-specific flooding threshold is closely related to real-world flood risks as assessed by the local weather forecast office.
2. We then used local sea level rise projections for 2030 and 2045 at the chosen tide gauges as one measure of climate risk for our sample of counties. These projections, developed by Climate Central, are based on NOAA's Intermediate-High scenario and adjusted to account for local variation based on historical tide gauge data (Climate Central 2015; Parris et al. 2012; Tebaldi, Strauss, and Zervas 2012). Where local sea level rise projections were unavailable for a particular tide gauge, projections from the nearest tide gauge were used.
3. We then used NOAA's online inundation analysis tool to calculate the frequency of flooding events at the chosen tide gauges based on the current flooding threshold—established by the local weather forecast office of the National Weather Service—and present-day sea level as well as for the projections of sea level rise in 2030 and 2045 (NOAA 2013b). This was our second measure of climate risk.
4. Finally we used the statistical technique of linear scaling to normalize the two variables (sea level rise and tidal flooding projections for 2045) and combined them into a single climate risk score for each county relative to the others in the sample (Dillard et al. 2013; Salzman 2003). See Figure 5, p. 16, for the relative climate risk indicator scores for each county. [22,23]

HOW WE DEVELOPED THE SOCIOECONOMIC RISK INDICATOR

To construct the socioeconomic risk indicator, we undertook three steps:

1. For each county, we gathered data on four variables from the U.S. Census QuickFacts data access tool, which is based primarily on data from the 2010 census and the 2009–2013 American Community Survey:[24] per-capita income, poverty rate, education, and the percentage of minority population.[25]
2. We used the linear scaling technique to normalize each variable to a 0–1 scale for each county (Dillard et al. 2013; Salzman 2003).
3. For each county, the linearized scores of the four variables were summed and averaged and expressed as a percentage, giving equal weight to each variable. This percentage score serves as the county's socioeconomic risk indicator (see Figure 6, p. 17, for the counties' scores).

These indicators should be seen as proxies for risk factors that contribute to a county's climate vulnerability; they are not determinants of specific outcomes. For our purposes, within a risk assessment framework, the climate and socioeconomic risk indicators we have developed provide a useful, transparent, easily replicable method with which to make an initial assessment of a county's vulnerability to sea level rise and accompanying coastal impacts.

[CHAPTER 4]

Our Results: Testing the Climate Equity Screening Tool

Sea Level Rise and Tidal Flooding

Global sea level is projected to rise by an average of about five inches above 2012 levels by 2030, and by about 11 inches by 2045 (Melillo, Richmond, and Yohe 2014). We found that one-third of the counties we studied are projected to experience sea level rise of 6 to 10 inches by 2030, and about half will experience 12 to 20 inches of sea level rise by 2045 (see Figure 3). Coastal communities in Louisiana and Virginia will be particularly affected, although all of the coastal counties in our analysis will experience more than four inches of sea level rise by 2030 and more than 10 inches by 2045.

Rising seas increase the likelihood of more frequent flooding from higher tides and further incursion inland of storm surge flooding. Nearly all of the 25 counties in the sample for which we have tidal flooding data and projections will experience at least a three-fold increase in tidal flooding events between now and 2030 and at least a 10-fold increase by 2045 (see Figure 4, p. 16).[26]

A Climate Risk Indicator

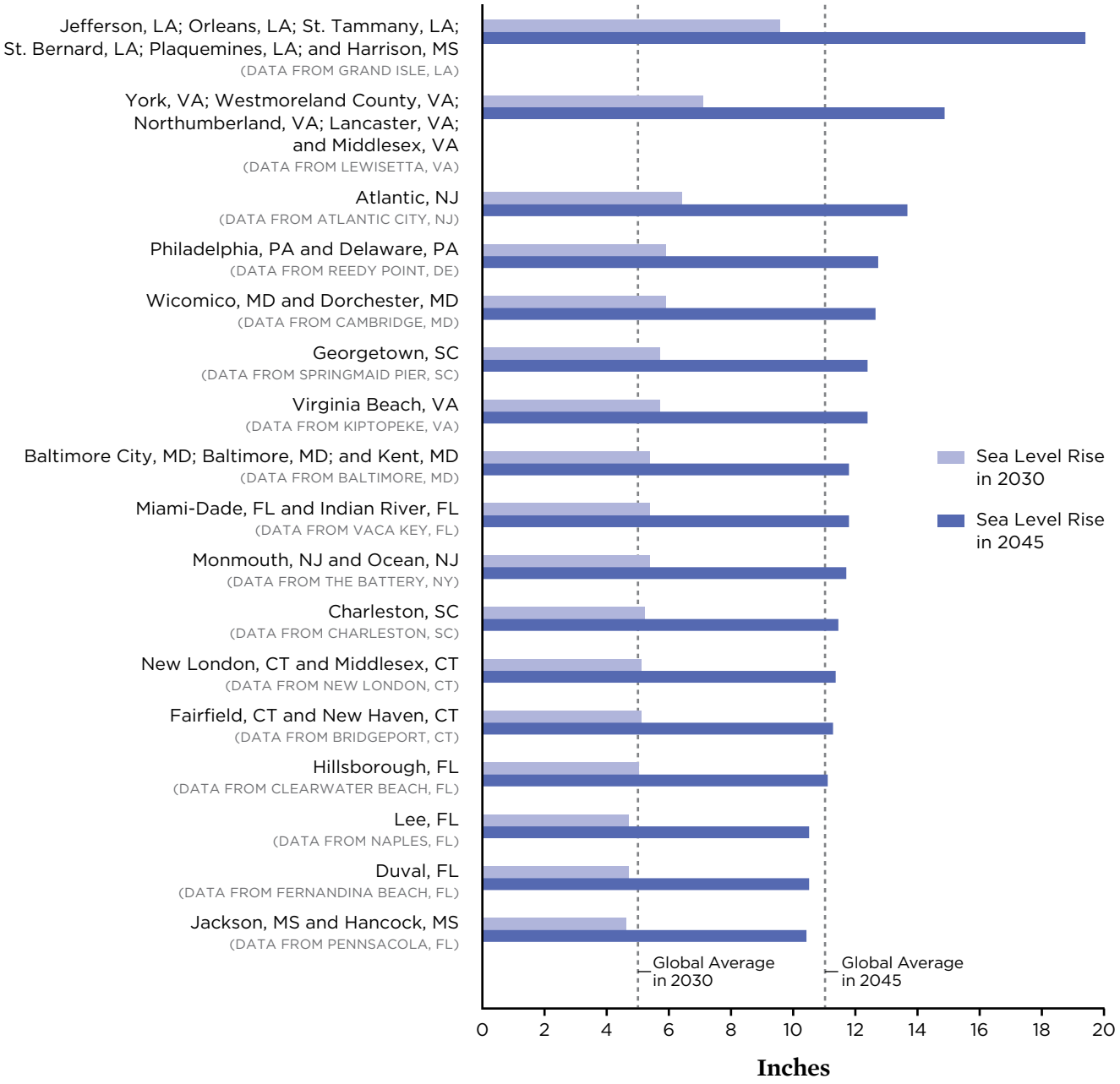
The two climate risk factors are combined to form a climate risk indicator (see Box 4, p. 13; and Figure 5, p. 16). The climate risk indicator is highest for most of the Gulf Coast counties in our sample—including Harrison County, MS, and those in Louisiana[27]—and is also high for most of the counties in the mid-Atlantic coast, from Virginia to New Jersey.

It should be noted that the low climate risk indicator for Jackson, MS, is primarily a result of data and methodology limitations. Tidal flooding data is not available for this county

Jacinta Quesada/FEMA

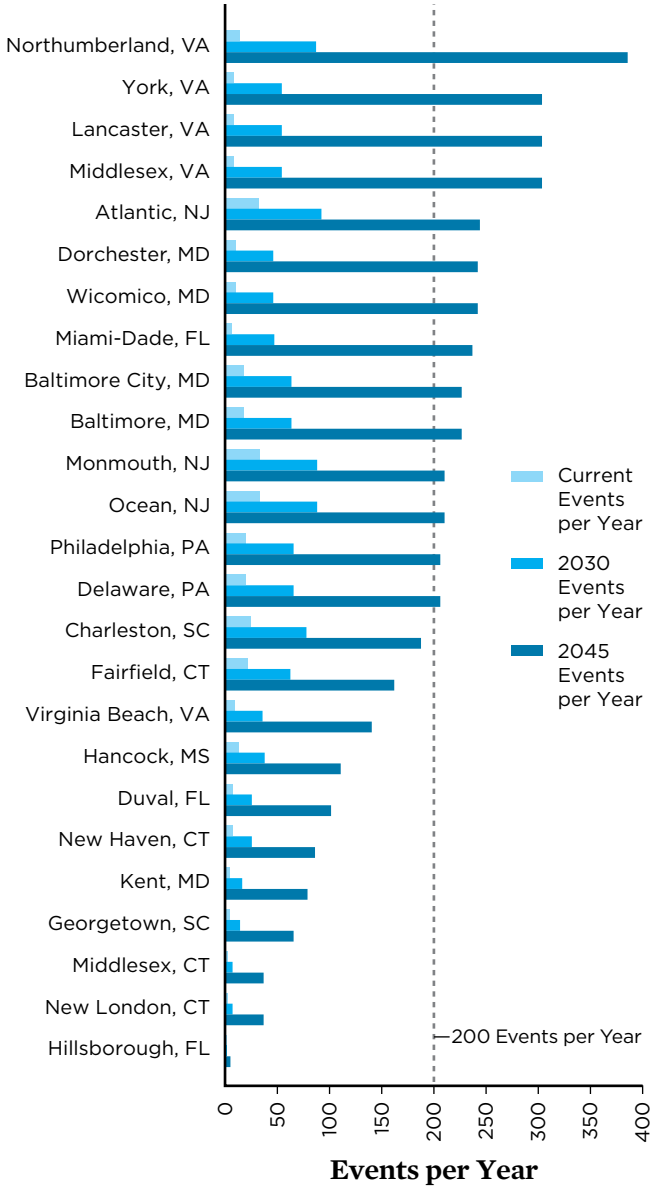
In the wake of Hurricane Gustav, a U.S. Army helicopter drops sand bags onto a broken levee in Plaquemines Parish, much of which lies below sea level and is particularly vulnerable to sea level rise and coastal flooding.

FIGURE 3. Sea Level Rise Projections for 2030 and 2045



Among the 35 coastal counties we analyzed, the five Louisiana parishes and Harrison County, MS, have the highest sea level rise projections, of nearly 10 inches by 2030 and nearly 20 inches by 2045, followed by counties in along the mid-Atlantic coast in Virginia, Pennsylvania, Maryland, and New Jersey. For each county in our sample, we identified the nearest, most appropriate tide gauge (listed in parentheses below the county names). We used sea level rise projections based on NOAA's Intermediate-High scenario and localized to each tide gauge by Climate Central to incorporate local variation.

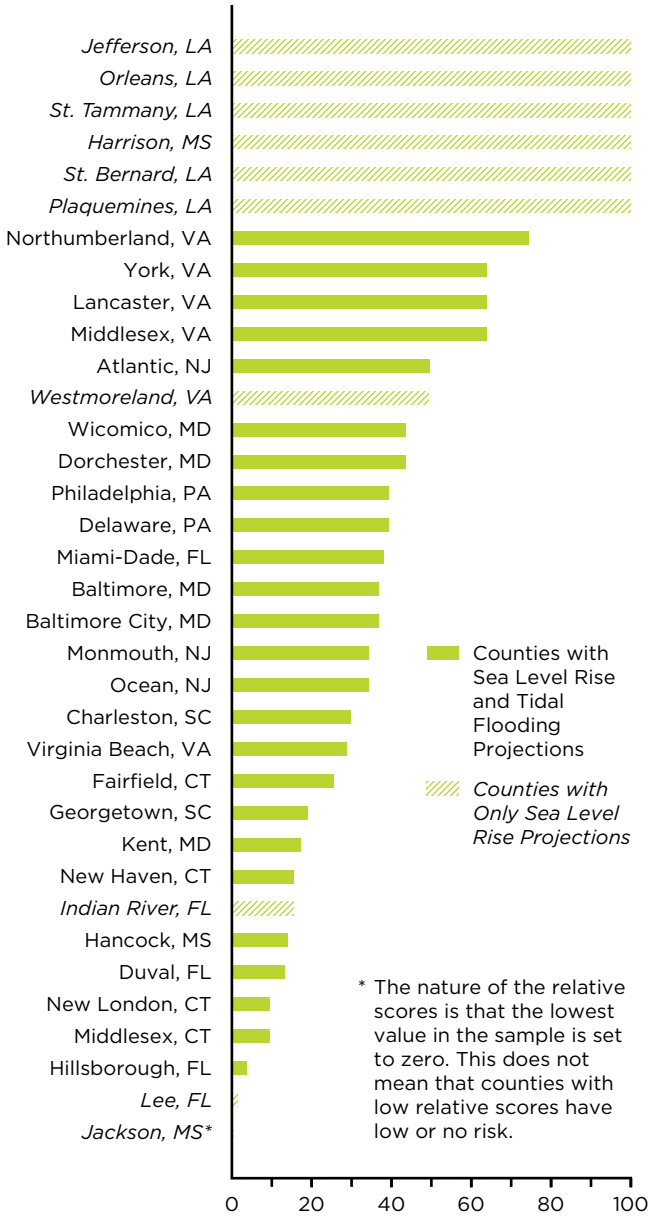
FIGURE 4. Tidal Flooding Today, in 2030, and in 2045



More than half of the 25 counties in our sample for which tidal flooding data are available are projected to have 200 or more annual flood events in 2045. The Virginia counties of Northumberland, York, Lancaster, and Middlesex have the highest projected flooding frequencies by 2045, with more than 300 annual flood events by 2045. The New Jersey and Pennsylvania counties, four of the five Maryland counties, and Miami-Dade, FL, follow with an average of 200 or more flooding events by 2045. Flood frequency projections rise fastest for Miami-Dade County in Florida, and York, Middlesex, and Lancaster counties in Virginia. These counties are all projected to experience approximately a 40-fold increase in flood frequency by 2045.

SOURCES: NCA 2014; CLIMATE CENTRAL 2012; UCS ANALYSIS

FIGURE 5. Climate Risk Indicators for the 35-County Sample (Relative to One Another)



The climate risk indicator is a composite of projections for sea level and tidal flooding for 2045. For 10 counties in our sample, the tidal flooding projections were unavailable due to data limitations; for those counties the risk indicator is derived solely from sea level rise projections for 2045. Of the 35 counties in the sample, the five Louisiana parishes; Harrison, MS; and the three Virginia counties have the highest climate risk indicator.

SOURCE: UCS ANALYSIS

so its risk indicator is based solely on sea level rise projections. While significant in absolute terms, with over 10 inches of sea level rise projected in 2045, relative to the other counties in our sample Jackson's sea level rise projection ranks last (see Figure 4). As a result, using our methodology, its climate risk indicator relative to the rest of the sample is zero.

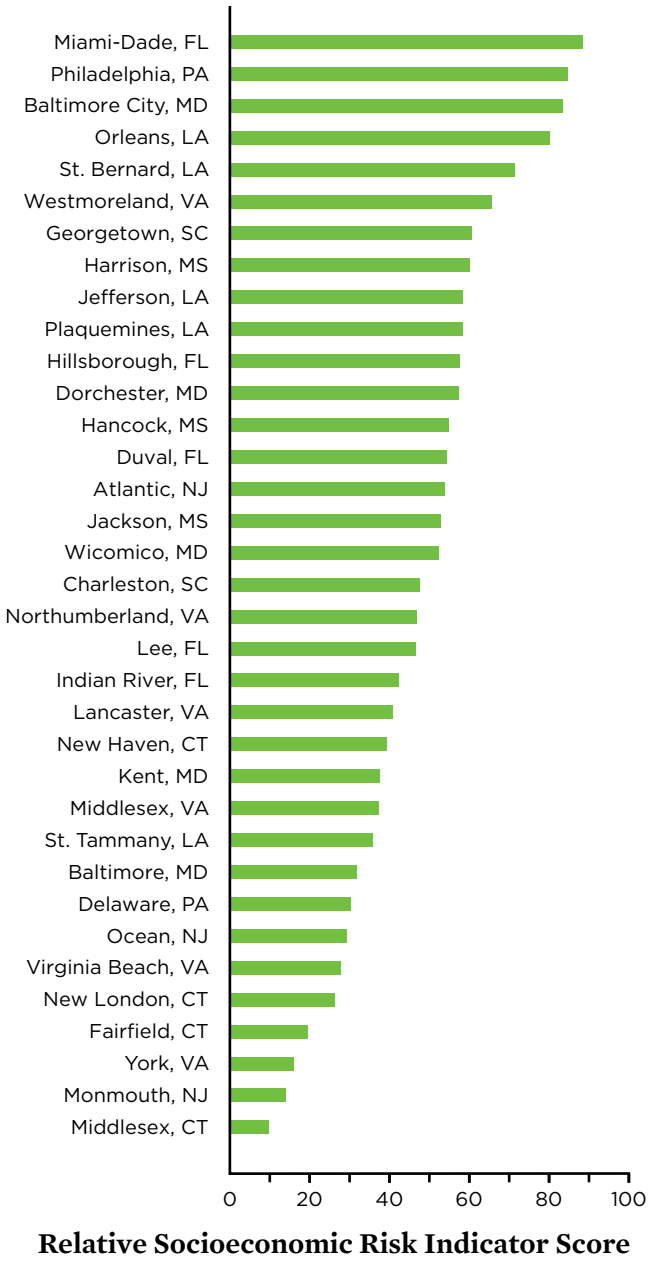
Socioeconomic Risk Factors for Climate Vulnerability

The 35 counties in our sample span a wide income range. Roughly three-quarters of the counties have per-capita income close to that of the average in the United States, but per capita income ranges from barely above $20,000 in St. Bernard Parish, LA, to nearly $49,000 in Fairfield, CT.[28] Poverty and educational disparities among the counties are even more pronounced than the income statistics reveal. Nearly two-thirds of the 35 counties have a higher poverty rate than the nation, including Orleans and St. Bernard Parishes in Louisiana, and the large urban areas of Miami-Dade, FL; Baltimore, MD; and Philadelphia, PA.[29] The same three urban areas fare poorly on educational attainment, with the percentages of adults over age 25 without high-school diplomas among the highest in our sample.

The share of African American and Latino populations varies widely among the counties. In nearly one-third of the counties, across six of the states, the share of African Americans in the population is twice the national average, and that share is much higher in Philadelphia, PA; Orleans Parish, LA; and Baltimore City, MD. The Hispanic or Latino presence in these coastal counties has a very different profile. In all but five of the counties, the share of the Hispanic population is smaller than its share of the national population overall. But in a handful of counties in Connecticut, New Jersey, and Florida, the share of the Hispanic population is higher than the national share, and it is highest by far in Miami-Dade, FL.

Our socioeconomic indicator of risk is calculated from four variables: per-capita income, poverty rate, educational attainment, and the percentage of minority population. (See Box 4, p. 13; Figure 6; and online technical appendix at *www.ucsusa.org/survivingandthriving*.) The data show that the counties encompassing three large cities—Philadelphia, Miami, and Baltimore[30]—are the most vulnerable places in our sample from a socioeconomic perspective. Two Louisiana parishes, Orleans and St. Bernard, are also among the top five most vulnerable. But every county on the list has socioeconomic factors that contribute to greater risk from climate change, even those that rank relatively low within our sample.

FIGURE 6. Socioeconomic Risk Indicators for the 35-County Sample (Relative to One Another)



The socioeconomic risk indicator is a composite of four variables: per-capita income, poverty rate, educational attainment, and the percentage of minority population. Relative to the 35 counties in our sample, this risk indicator is highest for the counties with the three largest urban population centers: Miami, Philadelphia, and Baltimore.

Our socioeconomic risk indicator shows a nearly 70 percent correlation with the national percentile ranking of those counties' county-level SoVI, one of the most widely used metrics of socioeconomic vulnerability, which provides validation for our choice of an abbreviated set of variables for the climate equity tool.[31]

The Dual Challenges of Sea Level Rise and Socioeconomic Vulnerability

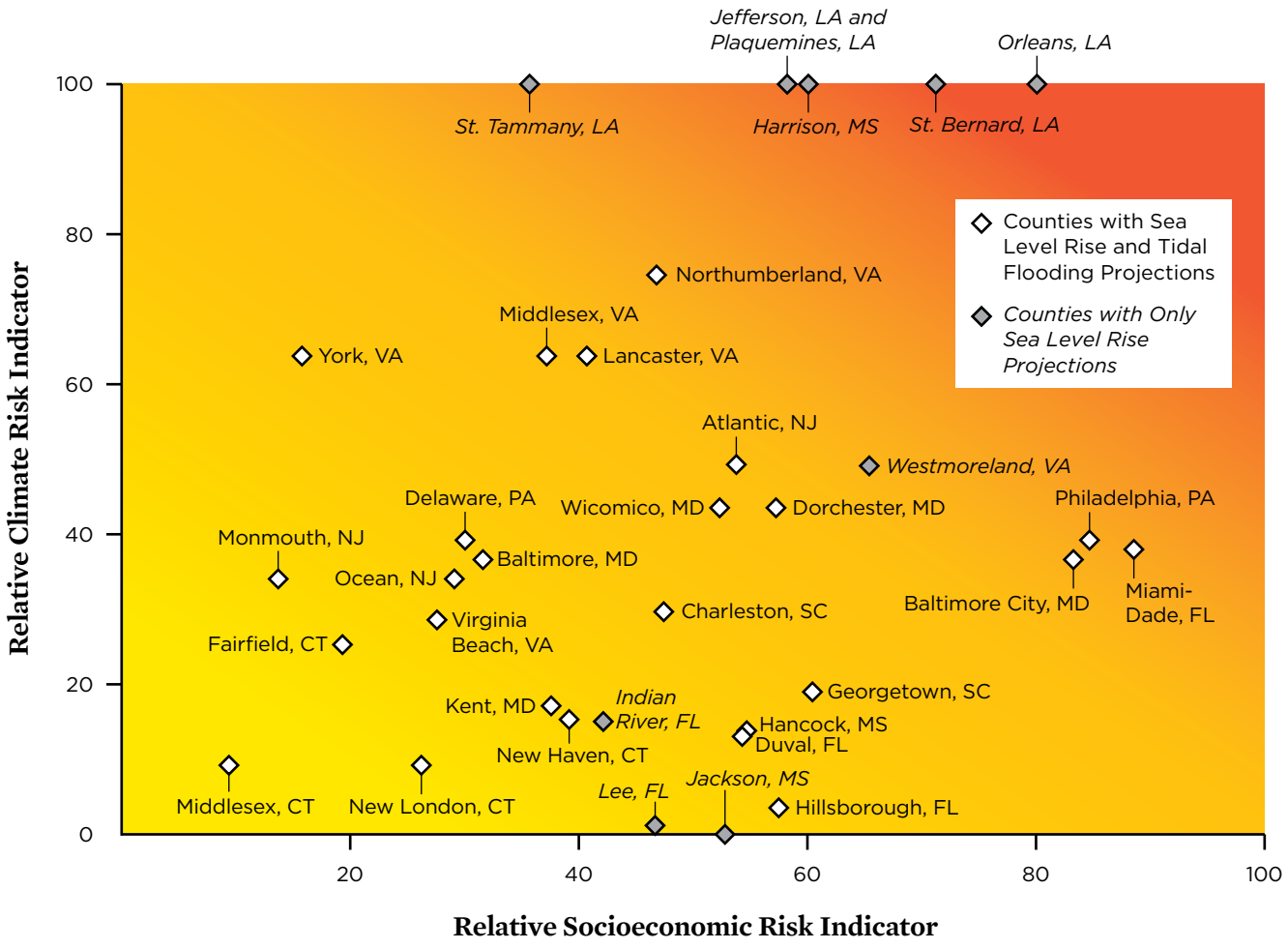
As a final step, we assembled the climate risk and socioeconomic risk indicators to create a joint risk profile for each county (see Figure 7). This allowed us to assess each county's overall vulnerability relative to the others in the sample. This pilot effort to create a climate equity screening tool shows some intuitively powerful results that are largely validated by the real-world experiences in these places (see Chapter 6, p. 30; and Box 5, p. 20–21, on past storm damages).

Orleans Parish, LA, comes up as the most vulnerable hotspot of the counties we analyzed, followed closely by neighboring St. Bernard, Jefferson, and Plaquemines parishes, and Harrison County, MS. From this joint risk perspective, other counties showing substantial risks are the large urban centers of Miami-Dade, Philadelphia, and Baltimore; Northumberland and Westmoreland counties in Virginia (followed by Lancaster and Middlesex); and Atlantic County in New Jersey. As noted above, the risk indicator information presented in Figure 7 shows *relative* risk for a county in relation to the 35-county sample we analyzed, and not to a nationwide average of county risk. Jackson, MS, has a relatively low joint risk ranking because of data limitations in developing its climate risk indicator (see section, A Climate Risk Indicator, p. 14). A low relative ranking for a county does not mean that it is exempt from climate concerns. Every coastal county will need to plan and prepare for sea level rise and address socioeconomic risk factors.

FEMA

In the wake of Hurricane Katrina, stranded residents of Jefferson Parish, including young children and seniors, are brought to an elevated bridge by boat to await transportation by truck to an evacuation staging area.

FIGURE 7. County-level Relative Joint Climate and Socioeconomic Risks



Counties that are climate equity hotspots can be identified by analyzing their joint climate and socioeconomic risks, and warrant further investigation into potential exposure risks for specific communities within them. The five Louisiana counties and Harrison, MS, rank relatively high in joint climate and socioeconomic risk at the county level. Several counties in Virginia, as well as the counties encompassing the major urban centers of Philadelphia, Miami, and Baltimore, also show relatively high joint risks. Even counties that rank relatively low will still experience some risk. Additionally, within counties there may be significant variation in risks which may be captured by future research using sub-county-level data.

The Value of an Equity Screening Tool

The equity screening methodology we present provides a starting point for the discussion of how to prioritize resilience investments to communities most at risk. Applying criteria like those included in our screening tool to every coastal county in the United States would help tell a more complete story of risk and help guide policy priorities more clearly and equitably. Counties identified as hotspots would also benefit from more research on risks to specific communities within them. This framework can also help raise awareness of challenges to building resilience, inform stakeholder dialogues about communities' choices for their future, and help build consensus around priorities.

The data we have used is readily available at the county level. The tool is designed to be flexible and transparent. It can easily be applied to more localized data where available, expanded with additional risk factors, extended to other

parts of the country, and adapted to different types of climate impacts. It could also be used over time to examine whether the relative risk profile of a community has improved with the investments in resilience.

Limitations of This Analysis and Opportunities for Future Research

Our simplified risk assessment framework is a way of distilling the confluence of climate and socioeconomic risk factors that contribute to the level of risk faced by a coastal community. This framework for climate equity hotspots should be seen as a risk assessment or screening tool—it is not meant to provide information suitable for detailed adaptation planning on the ground. The joint risks identified are applicable at the county level, but they should not be attributed to all places and all people living within the county. All risk indicator information presented here is relative to the 35-county sample we analyzed and is not meant to be an absolute indicator of risk. A low relative risk does not mean no risk, and in some towns or cities within such a low-risk county, there could be significant risk.

We tested the climate equity screening tool using county-level data because this was the level of aggregation at which consistent data were available. There are some advantages to this choice because it is the level at which many locally relevant policy and funding decisions are often made and many critical services are delivered (Benton 2005; Bobbit et al. 2005). More fine-grained data, however, with higher resolution than the county-level information we used, would help refine the indicators of risk for a community. This is especially true for counties where there is a significant variation in risk within the county (see Box 6, p. 22).

We used data from 21 tide gauges that were identified to be the closest suitable gauges to our county locations (see Figure 3, p. 15). While these tide gauge data provide a reasonable approximation of the risk of tidal flooding in a county, given a certain level of local sea level rise, there can be considerable within-county variation in whether flooding might actually occur—and how much—because of variations in local topography, whether a location is right on the coast or further inland, or whether human-made or natural barriers to flooding exist. More detailed location-specific data and modeling would further illuminate the level of specific place-based risks. As a practical matter, many local weather forecasting offices rely on nearby tide gauge data in issuing coastal flood advisories that cover one, or even several, nearby counties.

BOX 5.

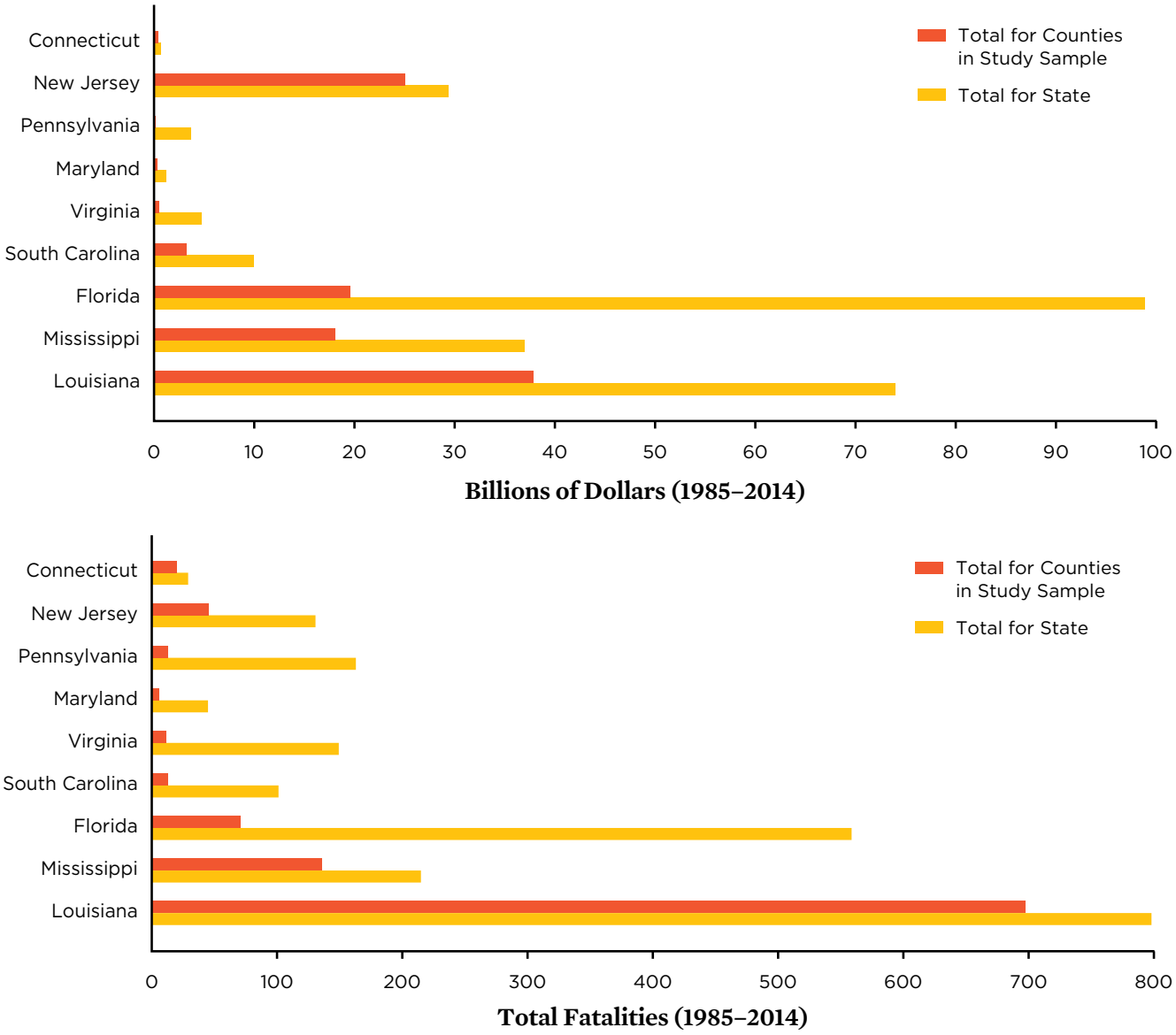
Damages from Past Storms

Geographical location, coastal topography, proximity to the warm waters of "hurricane alley" in the Atlantic Ocean, and other physical characteristics make some communities along the East and Gulf Coasts particularly susceptible to repeated storm and flood damages. To evaluate this exposure, we looked at data from the 2015 version of the Spatial Hazard Events and Losses Database for the United States (SHELDUS 14.0) (Hazards and Vulnerability Research Institute 2015), which is based on data from NOAA's National Climatic Data Center.[32] Our dataset covers past storm damages over a period of 30 years (1985–2014) for the 35 coastal communities in our sample (see Figure 8). We looked at storm categories most relevant for coastal impacts and focused on the dollar damages to property and crops, and fatalities.[33] There are other costs from storms, such as the costs of lost work days and health impacts, which are not captured by these data and can be substantial.

During the most recent 30-year period, storm- and flooding-related damages in the 35 coastal counties were highly concentrated in location and years of occurrence. The overwhelming majority of the damages and fatalities occurred in Louisiana, Mississippi (in 2005, mainly from Hurricane Katrina), New Jersey (in 2012, mainly from Superstorm Sandy), and Florida (mainly from Hurricane Andrew in 1992).

In 2005 alone, the five Louisiana parishes we studied suffered an estimated almost $38 billion in damages, and three counties in Mississippi had combined damages worth $18 billion (all values in 2014 dollars). Together, these eight counties accounted for more than half of the cumulative damages of the entire sample of 35 counties over the 30-year period. In New Jersey, Monmouth and Ocean counties faced a combined $24 billion in damages from Superstorm Sandy. In 1992, Hurricane Andrew is estimated to have caused nearly $11 billion in damages in Miami-Dade County, FL.

FIGURE 8. Harm from Past Storms, Damages and Fatalities (1985–2014)



The graph on the top shows the dollar amount of damages from past storms to property and crops in the states and counties highlighted in this report. On the bottom is a graph showing fatalities from storms. Louisiana, Florida, Mississippi, and New Jersey stand out in terms of the harm they experienced from past storms. (Dollar amounts have been adjusted to 2014 values.)

SOURCE: SHELDUS 14.0

With this screening tool we were not able to look at a county's increased risk of storm surge flooding, which is magnified by sea level rise and can cause catastrophic damage. There is a need for more sophisticated and localized modeling of climate and socioeconomic risk factors, for example, through storm surge modeling or modeling of economic impacts on local businesses susceptible to flooding, to provide additional insights. We were also unable to make future projections for the socioeconomic variables themselves and relied on current values instead. It is reasonable to expect considerable demographic shifts and some socioeconomic changes by mid-century, and projections of those changes could help inform long-term planning decisions today.

BOX 6.

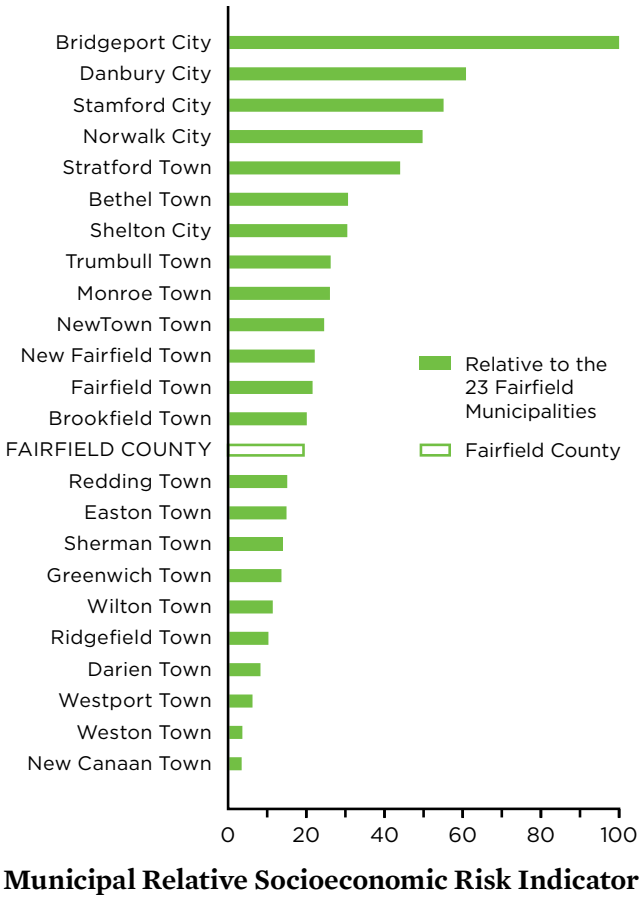
Significant Variation in Socioeconomic and Climate Risks within Fairfield County, CT

Climate risks and socioeconomic risks vary within a county, and the use of county-level data can sometimes mask pockets of high (and low) vulnerability within a county. To explore the value of using localized data in the screening tool, we looked at the relative risk in a variety of locations within Fairfield County, CT. At the county level, Fairfield compares favorably relative to the other counties in our sample with a low joint county-level climate and socioeconomic risk indicator (see Figure 7, p. 19). However, when we compare the 23 cities and towns (municipalities) within Fairfield County, the socioeconomic risk profiles vary significantly. For example, Bridgeport, Danbury, and Stamford are clearly at greater risk from a socioeconomic perspective than Greenwich, Darien, and Weston (see Figure 9).

Similarly, the risks from sea level rise and coastal flooding vary depending on a city or town's location relative to the coast within the county and other local factors. An analysis of areas within Fairfield County affected by tidal flooding today and in 2045 shows that there are eight towns along the coast that are affected, with the greatest impact in Stratford and Norwalk. Separately, we also used NOAA's Sea Level Rise Viewer tool to examine coastal flooding risks in Fairfield County (Office for Coastal Management 2015). NOAA's tool includes the ability to overlay data for the SoVI at the census-tract level with sea level rise projections. With one foot of sea level rise, large parts of Bridgeport show high overlapping risks from rising seas and socioeconomic factors. Stratford and Norwalk also have pockets of high joint risks and major areas with medium risks.

The use of county-level data likely masks pockets of high vulnerability within a county, yet even more granular spatial data may still not tell the whole story about who bears the burden of flooding impacts. For example, a relatively well-off family living very near the coast in a high flood-risk zone may not be as vulnerable as a low-income household that is located further inland but depends on an income earned in a hotel right on the shoreline.

FIGURE 9. Variation in the Relative Socioeconomic Risk Indicator within Fairfield County, CT



CHAPTER 5

Building a More Equitable Climate Resilience Framework

Our nation's disaster aid, recovery efforts, and investments need to better correspond to individual communities' risk and current level of preparedness, and need to meet the needs of those most at risk. Many existing programs administered by FEMA are currently targeted at homeowners or businesses, leaving people who rent or live in public housing at a disadvantage.[34,35] Evacuation plans are primarily geared toward individuals who own cars or can afford to pay for transportation and may not always factor in the needs of those with health or mobility challenges. Aging and inadequate infrastructure such as storm-water and sewage systems can contribute to flooding and pollution in communities, as experienced in the wake of Hurricane Katrina and Superstorm Sandy. State and federal agencies also sometimes lack familiarity with the specific concerns of communities. Bureaucratic hurdles can make aid less accessible to residents in a time of crisis, and the use of a traditional cost-benefit test for project approval can leave low-income communities at a significant disadvantage in accessing funds. Importantly, current aid and recovery programs are not administered with an eye to building climate resilience in places most at risk.

Building on our research, and on discussions at the NAACP-UCS Climate Equity Convening in November 2014 (see Box 3, p. 8), **the guiding principle for all of our recommendations on climate resilience is a commitment to providing communities equitable access to the resources and know-how they need to make choices about their future in a world of rising seas**. As the United States invests in resilience along the nation's coasts, we must help all Americans to safeguard their homes and communities.

Recommendations

All frontline communities need to be prepared for future disasters and ongoing challenges from sea level rise and coastal flooding. Screening tools, such as the climate equity hotspot tool we have developed, can help identify people and places particularly at risk that require extra attention and resources. The federal government should work closely with state, local, and tribal authorities to help ensure that these frontline communities are better prepared and protected and that taxpayer dollars are spent wisely. UCS recommends that:

1. **Federal, state, and local agencies should target funding for preparedness and disaster recovery to communities most at risk.** Funds and technical expertise from federal aid programs should be specifically allocated to meet the needs of frontline communities, using socioeconomic and climate risk factors such as those identified in our screening tool to prioritize communities

Climate equity screening tools can help identify people and places particularly at risk and that require extra attention and resources.

FEMA

Volunteers, such as the AmeriCorp volunteer pictured here, are often crucial to rebuilding and recovery efforts following disasters.

most at risk.[36] These programs include FEMA's Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program, and disaster aid programs; HUD's Community Development Block Grant Program; and the Department of Transportation's Public Transportation Emergency Relief Program; among others.[37] Rebuilding in the wake of extreme weather events, and investments in long-lived infrastructure, should be done with an eye to enhanced climate resilience. For example, states should follow new guidance from FEMA to incorporate climate change considerations in scoping and developing their hazard mitigation projects (FEMA 2015). The grant application process should be made more streamlined and more easily navigable, allowing disadvantaged communities to access funds more easily and in a more timely way.

2. **Policy makers should direct investments in transportation, energy, health, and shelter to meet the needs of populations at heightened risk.** Meeting basic needs can be challenging in the aftermath of a disaster, especially in communities where infrastructure investment has lagged or is in serious disrepair. Federal and state agencies should plan ahead and make smart investments that can help ensure that people are able to get out of harm's way or able to shelter in place safely, and that critical infrastructure and services are restored quickly. For example, investments in resilient microgrids and power storage technologies in vulnerable communities can help ensure that hospitals and other critical facilities are able to provide uninterrupted service during emergencies. Where possible, agencies should look for synergies in programs, such as worker training assistance programs, community development programs, clean energy retrofit programs, and community health programs, that can be leveraged to ramp up local resilience. These steps can limit disruptions to schooling, employment, housing, healthcare, and other important aspects of communities' well-being, thus reducing the need for longer-term taxpayer-funded assistance.

3. **Federal and state agencies should ensure that affordable housing is upgraded and made climate-safe.** The lack of affordable housing is already a crisis in many parts of the country. Much of the existing public housing stock is old and is often located in the least economically

Rebuilding in the wake of extreme weather events, and investments in long-lived infrastructure, should be done with an eye to enhanced climate resilience.

> ***We must marshal the public funds necessary to upgrade public housing to make it climate-safe while maintaining affordability.***

desirable, often environmentally compromised areas. High-rise public housing buildings are difficult to bring into compliance with current FEMA flood risk standards, let alone to make safe from future flood risks from rising seas. Updating these buildings so they meet standards may be very expensive in some cases and may mean that rents would become unaffordable for the people who rely on such buildings for housing. We must marshal the public funds necessary to upgrade public housing to make it climate-safe while maintaining affordability (Furman Center 2014).

This requires rethinking some policy priorities. For example, much of FEMA's pre- and post-disaster assistance and guidelines for retrofitting buildings for flood resilience are aimed at single-family or two-to-four-family buildings, leaving large multi-family apartment buildings or rental units (which have a disproportionate share of minority and low-income households) at a considerable disadvantage. It is critical to increase funds for building and maintaining affordable housing and reverse steep cuts in HUD's HOME Investment Partnerships Program and Public Housing Capital Fund, which are important sources of funding for this purpose.[38] Another example of policy reform could be allowing some multi-family residential buildings to be "dry flood-proofed" (i.e., making flood-prone parts of buildings watertight), which is a relatively inexpensive option not currently recognized by FEMA as a way to lower flood insurance premiums (Furman Center 2014). Other innovative solutions like combining energy efficiency retrofits with flood resilience retrofits could also help achieve better, more cost-effective outcomes and allow access to diverse sources of financing (Furman Center 2014). A close examination of the effectiveness of tax breaks to real estate developers, relative to other options such as using the money to directly fund rental assistance, is also needed (Hutchins 2015).

4. **The federal government should mandate and enable the use of the best-available actionable science, data, mapping, and tools.** Federal, state, and local adaptation planning should be informed by the best-available, actionable climate science and must be developed in consultation with local stakeholders. A national commitment and funding will be required to scale up these efforts, link them where useful, localize the information as much as possible, make the data and tools widely accessible to communities, and build local capacity to use them.

FEMA

Following the destruction of municipal buildings in Gulfport, MS, during Hurricane Katrina, FEMA funded the construction of the Robert J. Curry Public Safety Center. The center includes a police station and municipal courts, was built to specification to act as a community shelter, and includes such resilience measures as emergency generators and backup sewer storage.

BOX 7.

Making Hard Choices along Our Coasts

Coastal communities have a few options in how they respond to rising seas: investing in human-made or natural barriers to keep the water out, coexisting with water in ways that limit its interference with daily life, or retreating from some of the most risky places. However, not all of these options are available everywhere. They all require resources to evaluate and implement, and, as climate change accelerates, the options available to a community may shrink (although options within the three broad categories of investing, coexisting, and retreating could expand with technological, economic, and social changes).

From a climate equity perspective, it is important to ensure that investments in coastal resilience flow equitably to all communities and that historically disadvantaged communities are not short-changed. Using a traditional cost-benefit calculation, in which the monetary value of property is the sole criterion for decisions about what to protect and what to abandon, could leave some low-income communities at a disadvantage in getting protective measures. For example, a recent study found this exemplified in the Gulf Coast region, where more than 99 percent of the most socially vulnerable people live in areas that are unlikely to be protected from inundation if pure economic efficiency criteria are used to make the determination of what to protect (Martinich et al. 2013).[39]

Nevertheless, some of the places most at risk from sea level rise may eventually have to be abandoned. Some communities—often including the most socially vulnerable residents—will need to relocate to safer areas because protective measures will not be enough. It is critical to ensure that even under those extreme circumstances, displaced communities have choices and resources to ease the transition.

> *"In Southwest Louisiana, [climate-change-induced] migration is already occurring and there is no federal policy in place to help. In all the talk about preparedness, no one is talking about relocation. [Researchers at] Tulane University analyzed relocation policy, and pointed out that there is no policy that allows communities to move as communities. It will be difficult for Cajuns to be Cajun if they don't live near the waters of the Gulf."*
>
> — Cynthia Sarthou, executive director, Gulf Restoration Network [40]

When communities have better information about their risks, they can make informed choices about prioritizing the mitigation measures they wish to undertake. The Obama administration's Climate Data Initiative is an important step forward. But federal government agencies need adequate funding from Congress to create publicly accessible databases for those data critical to planning and preparedness efforts, and to create tools that allow different types of data coming from different agencies to be more easily integrated in order to give a fuller picture of the multiple stressors that communities might face. Recent helpful examples include NOAA's digital coast tool and the EPA's EJSCREEN tool. Additional data layers and more localized information, accompanied by robust capacity building and technical assistance efforts, are necessary. (Office of Atmospheric Programs 2015; Office for Coastal Management 2015).

5. **Congress should increase funding for climate resilience.** Congress should help prepare and protect at-risk communities by increasing funding for pre- and post-disaster hazard mitigation and recovery or creating a well-financed national resilience fund, coupled with long-term climate planning criteria. Funding for frontline communities needs to be prioritized using climate and socioeconomic criteria similar to those identified in our equity tool.
6. **The federal government should enforce and implement existing regulations and policies equitably.** Studies have shown that the enforcement of existing environmental, health, housing, land use, and civil rights

laws, such as Title VI of the Civil Rights Act, can go a long way toward reducing disproportionate burdens on communities of color and low-income communities (Bullard et al. 2007). In addition, preparedness efforts should not only minimize new risks, but actively lessen the burdens that some communities already face. For example, the common-sense **federal flood risk management standard**—which requires future federal investments in floodplains to meet standards for climate resilience—should be implemented in a robust way while ensuring that it does not inadvertently harm housing affordability in low-income communities. Rate increases under the **National Flood Insurance Program** are necessary to bring premiums in line with flood risks, but they must include affordability provisions for low- and fixed-income homeowners. A recent report from the National Research Council, *Affordability of National Flood Insurance Program Premiums,* highlights some promising strategies for doing so, including means-tested flood mitigation grants, flood mitigation loans, vouchers, and encouragement of higher premium deductibles (NRC 2015).

7. **The United States should work with other nations to cut carbon emissions.** Our nation's efforts to build coastal resilience—in socioeconomically at-risk communities as well as more affluent ones—will be quickly overwhelmed if climate change and sea level rise continue unchecked. Measures we take to contain the extent of the problem are critical to the success of our efforts to manage climate risks at the community level. Deep cuts in global carbon emissions are needed to help slow the pace and limit the magnitude of sea level rise and other climate impacts over the long term. Cost-effective solutions to cut emissions are readily available, particularly through ramping up renewable energy and energy efficiency, and more should be done to make those options available to all communities. Embracing a vision of sustainable low-carbon development is essential to meet climate goals and for the nation's future prosperity.

Robust, Inclusive Stakeholder Engagement

Measures we take to improve coastal resilience in an equitable way must be informed by **a robust, inclusive process of stakeholder engagement** with representatives of frontline communities at the table, having a direct voice in shaping their future.[41] This is all the more important for communities that have been historically marginalized for socioeconomic, political, racial, or ethnic reasons, and where extra effort must be made by policy makers and implementing agencies to build collaborations based on trust (Douglas et al. 2011). As a participant at the NAACP-UCS Climate Equity Convening remarked, the past experience of some communities has been that "if you're not at the table, you're on the menu."

An inclusive process may include things such as providing translation services for non-English speaking participants; choosing times and places for community engagement that are convenient for participants, such as making accommodations for work schedules, choosing meeting locations near public transit, and providing childcare and refreshments; and using meeting facilitation techniques that ensure that all participants feel welcome and comfortable speaking up.

As the recent NAACP report *Equity in Building Resilience in Adaptation Planning* states: "To be able to declare that community resilience has been achieved, we must develop systems that address the needs and provide protection for those most vulnerable and marginalized." (NAACP 2015).

Drawing from and adapting the 1996 Jemez Principles for Democratic Organizing, as the nation builds equitable climate resilience, agencies and policy makers must engage with a diverse group of stakeholders and ensure (Jemez Principles 1996):

- an inclusive process for making and implementing resilience policies;
- that people and communities can speak for themselves;
- the use of the best-available climate science, including projections for the future and updates as they become available;
- equitable access to funding and planning resources for all communities;

> ***When communities have better information about their risks, they can make informed choices about prioritizing the mitigation measures they wish to undertake.***

FEMA

Plaquemines Parish residents speak with a FEMA representative about their concerns for their communities' future as they recover from Hurricane Katrina.

- transparency, accountability, and follow-through by responsible parties; and
- transformative changes that meet the needs of communities facing complex challenges.

The principles embedded in FEMA's "whole community" approach, which were developed in consultation with the agency's local partners including representatives of states, tribes, communities of color, faith-based groups, and nongovernmental organizations, can help lead to better outcomes for emergency preparedness and emergency management (FEMA 2011). A serious effort to implement this approach must include a process of building trust and creating a level playing field for all communities *before* a disaster strikes. Effective community partnerships require engaging with community members proactively, sharing information, and involving community leaders in planning and decision-making processes.

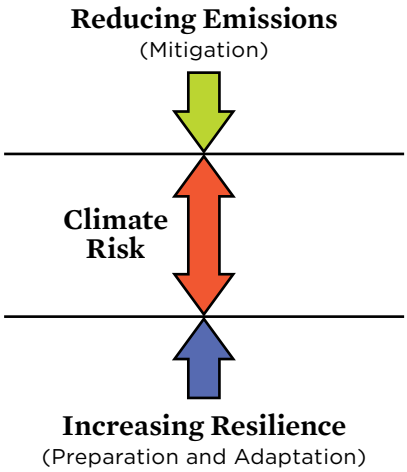
> ***Deep cuts in global carbon emissions are needed to help slow the pace and limit the magnitude of sea level rise and other climate impacts over the long term.***

Conclusion

With worsening impacts from sea level rise and flooding bearing down on communities across the nation, we must work to prepare and protect people and summon the political will to address our fossil-fuel dependency and cut emissions (see Figure 10). The federal government should work closely with state, local, and tribal authorities to increase community resilience and ensure that taxpayer dollars are invested efficiently and effectively. Screening tools, such as the climate equity hotspot tool developed by UCS and described here, can help identify communities that are at particularly high risk and that demand extra care, attention, and resources to minimize harm and loss of life in future disasters.

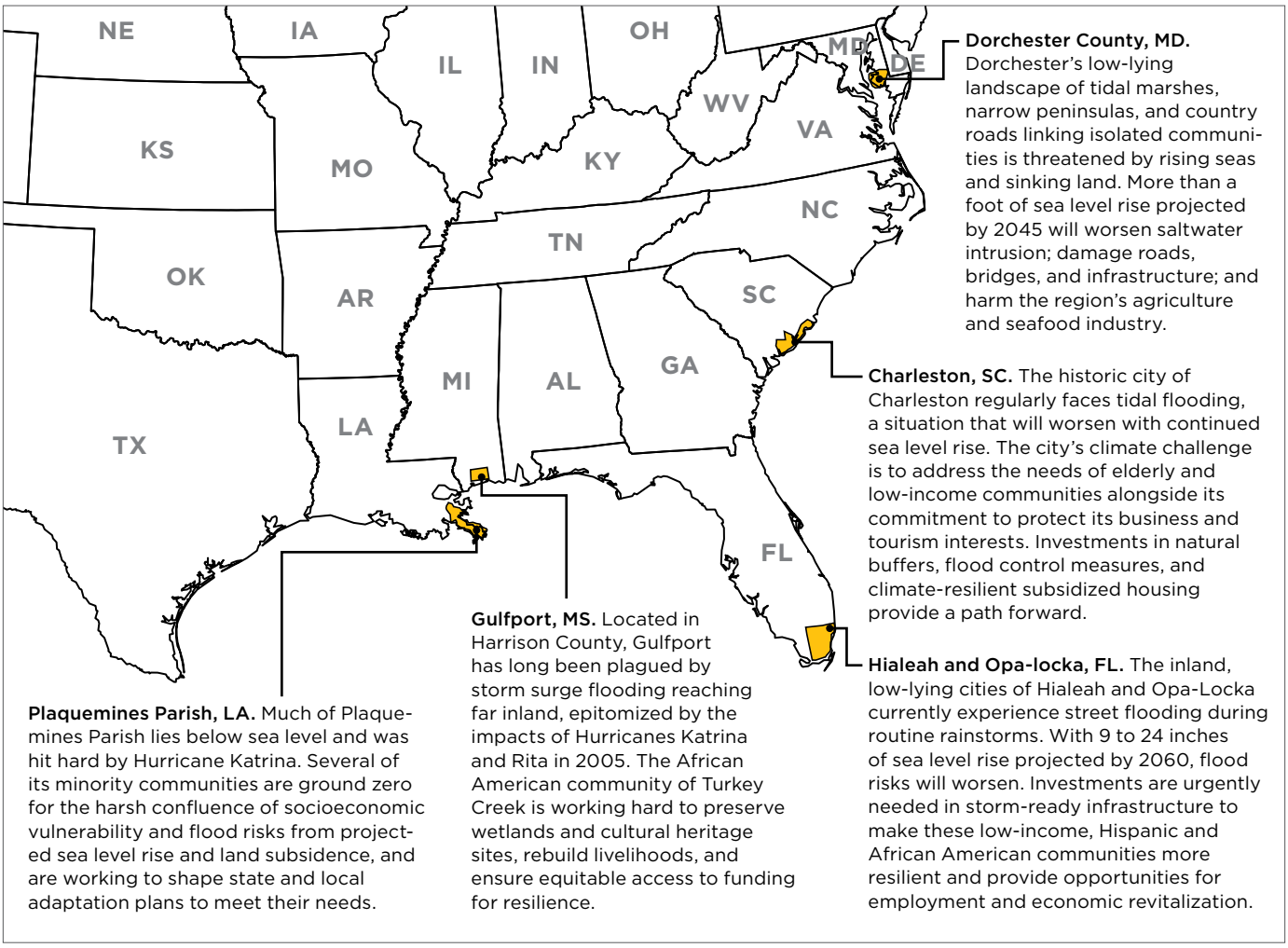
The efforts of local environmental and climate justice groups in the face of accelerating climate risks attest to the strength and endurance of frontline communities. They are also a reminder that **if we fail to take action to protect frontline communities, the devastation and hardships they face today will be a reality for many more communities tomorrow**. Building climate resilience requires marshaling resources and know-how so that communities can make well-thought-out choices about their future that help them survive and thrive. As a nation, we have to ensure that fairness and equity are an integral part of our climate solutions.

FIGURE 10. Limiting Climate Risks



Actions we take to prepare and adapt to climate change and efforts to reduce carbon emissions are vital to limiting both the pace and magnitude of climate change and the risks it poses.

FIGURE 11. Case Studies in Coastal Climate Equity Challenges



The five case studies included in this report highlight communities along the East and Gulf Coasts that face growing threats from sea level rise and storm surge and require a more equitable policy response.

> *"If my community has never seen you before a storm, why should we talk to you now the storm has come? Why not give us a stipend to come to a workshop on preparedness? [Government agencies] need to bring something to our communities first, beyond conversations in the aftermath and promises. People here are still waiting on promises summed up as '40 acres and a mule'."*[42]
>
> — Queen Quet, head of state, Gullah/Geechee Nation[43]

CHAPTER 6

Case Studies

Dorchester County, MD: Historic, Isolated Communities at Risk

WRITTEN BY RACHEL CLEETUS

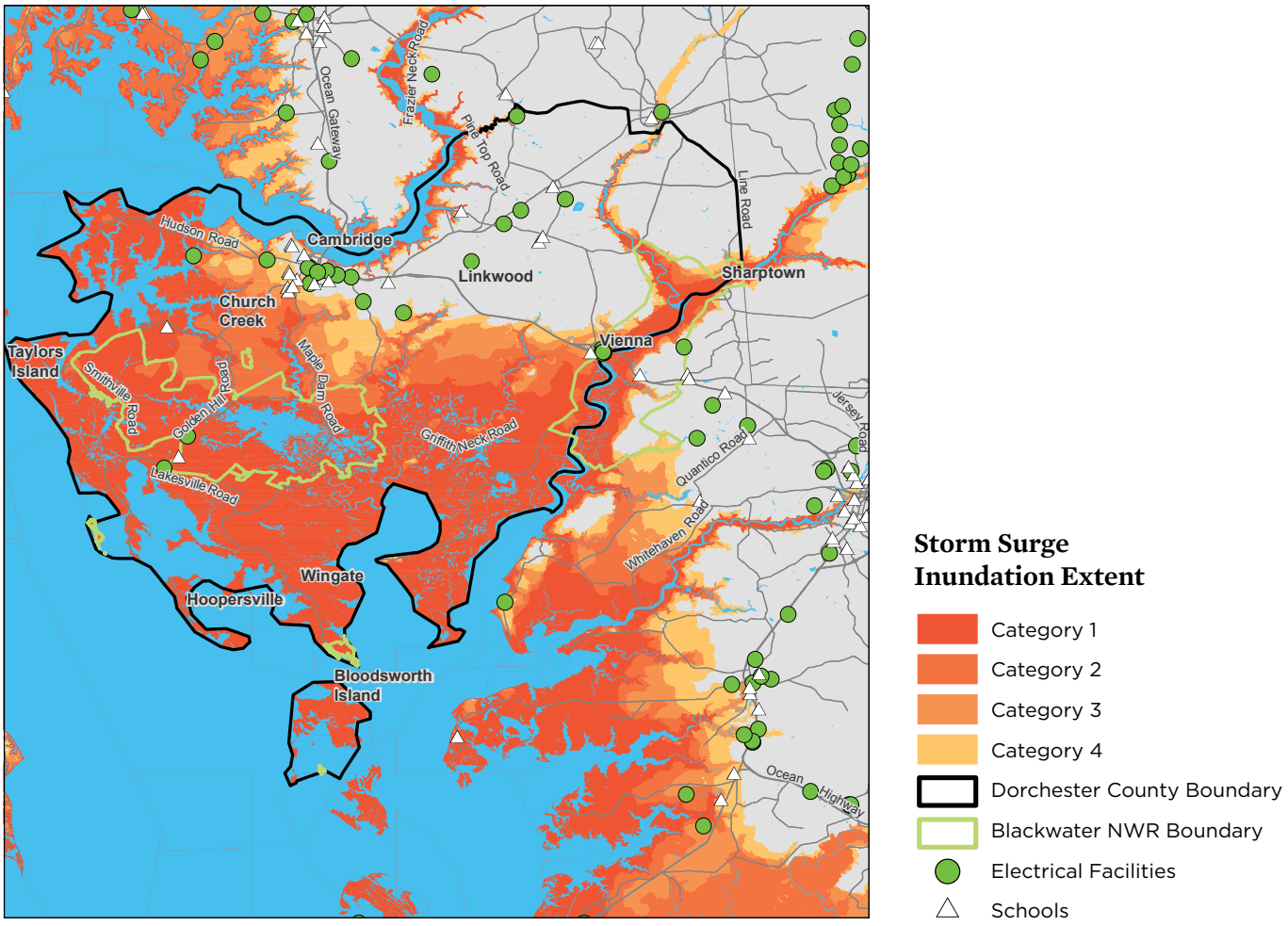
Dorchester County, MD, faces serious threats from rising seas and sinking land, with its low-lying landscape of tidal marshes, narrow peninsulas, and country roads linking small, isolated communities (Maryland DNR 2008). More than 55 percent of the county lies in the 100-year floodplain, much of it in the tidal floodplain (Dorchester County Government 2015); even minor storms and routine high-tide events can flood vast portions of the county.[44] When Hurricane Isabel hit the region in 2003, it caused record-breaking storm surge, reaching up to eight feet and resulting in immense damage to homes and livelihoods (Hovis et al. 2004). Superstorm Sandy in 2012 brought heavy rain and flooding to communities on the Eastern Shore, including some near Dorchester. With rising seas, sea water is encroaching farther inland, converting more areas from freshwater marshes to salt marshes and eventually to open water. These types of changes to marshes can disturb ecosystems necessary for fish and shellfish and can lessen their ability to function as buffers to storms and water filtration systems (O'Brien and Walton 2011).

Sea level in Dorchester County is projected to increase by more than a foot by 2045 (Climate Central 2015). A 2014 report from the Union of Concerned Scientists found that, under a mid-range scenario of sea level rise, tidal flooding in Cambridge, MD (the county seat), would increase from 10 events in 2015 to more than 240 in 2045 (Spanger-Siegfried, Fitzpatrick, and Dahl 2014). Sea level rise along the mid-Atlantic coast is occurring faster than along

H. Seymour Squyer

Dorchester County, the birthplace of Harriet Tubman, the famous abolitionist who led hundreds of enslaved people to freedom along the Underground Railroad, faces serious threats from rising seas and sinking land. Already, the waters of the Chesapeake Bay near the Tubman memorial have risen more than 10 inches over the past 70 years and may rise another 15 inches by 2050.

FIGURE 12. Dorchester County, MD: Present-day Exposure to Storm Surge from Different Categories of Hurricanes



While hurricanes more commonly make landfall along the Gulf and southeastern coasts of the United States, those that do make their way farther north can have devastating consequences. A Category 1 hurricane in Dorchester County, MD, for example, has the potential to inundate large swaths of the county, including the towns of Hoopersville and Wingate as well as the majority of the Blackwater National Wildlife Refuge (areas colored deep orange). Stronger storms—Categories 2, 3, and 4—would inundate even larger areas (colored in lighter shades of orange and yellow) and pose greater flood risks to critical infrastructure such as schools, electrical facilities, and roads. With rising seas, future storm surges will reach farther inland. In addition, warming oceans are expected to contribute to more intense hurricanes.

SOURCE: UCS ANALYSIS USING NOAA'S STORM SURGE MODEL (SLOSH, AT *WWW.NHC.NOAA.GOV/SURGE/SLOSH.PHP*)

other parts of the Atlantic coastline due to local and global factors, such as land subsidence, changes in the Gulf Stream, and climate change (Ezer et al. 2013; Boon, Brubaker, and Forrest 2010). A 2013 report from the Maryland Climate Change Commission recommended that the state plan for a relative sea level rise of 2.1 feet by 2050 and 3.7 to 5.7 feet by the end of the century (Boesch et al. 2013).

Dorchester County is the birthplace of Harriet Tubman, the famous abolitionist who led hundreds of enslaved people to freedom along the Underground Railroad (Holtz et al. 2014). The area was settled by freedmen and women after the Civil War. Since the land was low-lying and swampy, it was considered less desirable and was therefore one of the few places that African Americans could afford to own property after slavery ended (Kobell 2014). Today, the county is nearly 30 percent African American, and 18.4 percent of residents live below the poverty line (U.S. Census 2015).

Dorchester's African American residents are particularly at risk from flooding. Christine Miller Hesed, a researcher at the University of Maryland Department of Anthropology, explains:

> *The vulnerability of African American communities on the Eastern Shore is exacerbated by their longtime social and political isolation. In the past these communities have been largely self-sufficient in responding to periodic flooding; however, the increased frequency and magnitude of flooding events along with the outmigration and aging within these communities means that they must now look for assistance from the techno-bureaucratic world of policymaking and regulation with which they have little experience in navigating.* (Miller Hesed 2015)

In the aftermath of Superstorm Sandy, residents of Crisfield in next-door Somerset County experienced multi-day flooding and found that aid and rebuilding dollars were slower to come to them than nearby affluent areas (Miller Hesed and Paolisso 2015; Kobell 2014).

Roads in Dorchester County already flood regularly during high tide. Residents cope by using alternate routes and, if necessary, by temporarily relocating (Miller Hesed and Paolisso 2015). In some cases, people have elevated their homes as a protective measure. However, even one foot of sea level rise will significantly worsen impacts already being felt. In addition to flooding, the future will likely bring further saltwater intrusion, failure of septic systems in rural communities, and damage to roads, bridges, and other infrastructure. Changes to the coastal ecosystem will also affect the primary local sources of livelihood: agriculture, forestry, and the seafood industry (Maryland DNR 2008). For example, large areas of farmland are being lost to marsh (Nuckols et al. 2010). Added to this is the social and cultural loss that will be painfully felt by these historic communities that may have to disperse and relocate (Miller Hesed 2015; Orlove 2009).

The state of Maryland has developed an ambitious climate adaptation plan. The Living Shoreline Protection Act, the Chesapeake and Coastal Bays Critical Area Act, and the Climate Change and Coast Smart Construction Executive Order are intended to help restore natural buffers to coastal flooding, limit development in high-risk areas, and ensure that state agencies include sea level rise risks in their planning and activities (Maryland Commission on Climate Change 2013). State planners indicate that roads will likely be maintained and raised over time, in some cases functioning as dikes (Nuckols et al. 2010), but this is costly and may not be possible everywhere over the long term. The Maryland State Highway Administration is developing a methodology to evaluate the vulnerability of the state's roads and bridges to climate-related risks (Habic 2015). This can help guide decisions about how to meet infrastructure investment needs.

For Dorchester County, the reality is that large areas may be lost to sea level rise or cut off from interior areas within the next few decades, forcing difficult decisions for residents (Paolisso et al. 2012). Given that more isolated areas in Dorchester County are facing declining employment prospects and a falling population, it seems unlikely that they will see significant public investments in shoreline protection (Nuckols et al. 2010)—protective measures will likely be targeted toward larger population centers such as Cambridge. Frontline communities in Dorchester and neighboring Eastern Shore counties, many with strong historical and cultural ties to the locale, will need sufficient resources to help plan for the future and make choices about how best to protect themselves from tidal flooding, encroachment of saltwater, and coastal disasters of the coming years.

"The vulnerability of African American communities on the Eastern Shore is exacerbated by their longtime social and political isolation."

Christine Miller Hesed, researcher, University of Maryland Department of Anthropology

Charleston, SC: Historic City at Risk of Flooding

CO-WRITTEN BY LIZ SCHMITT AND MELISSA DEAS

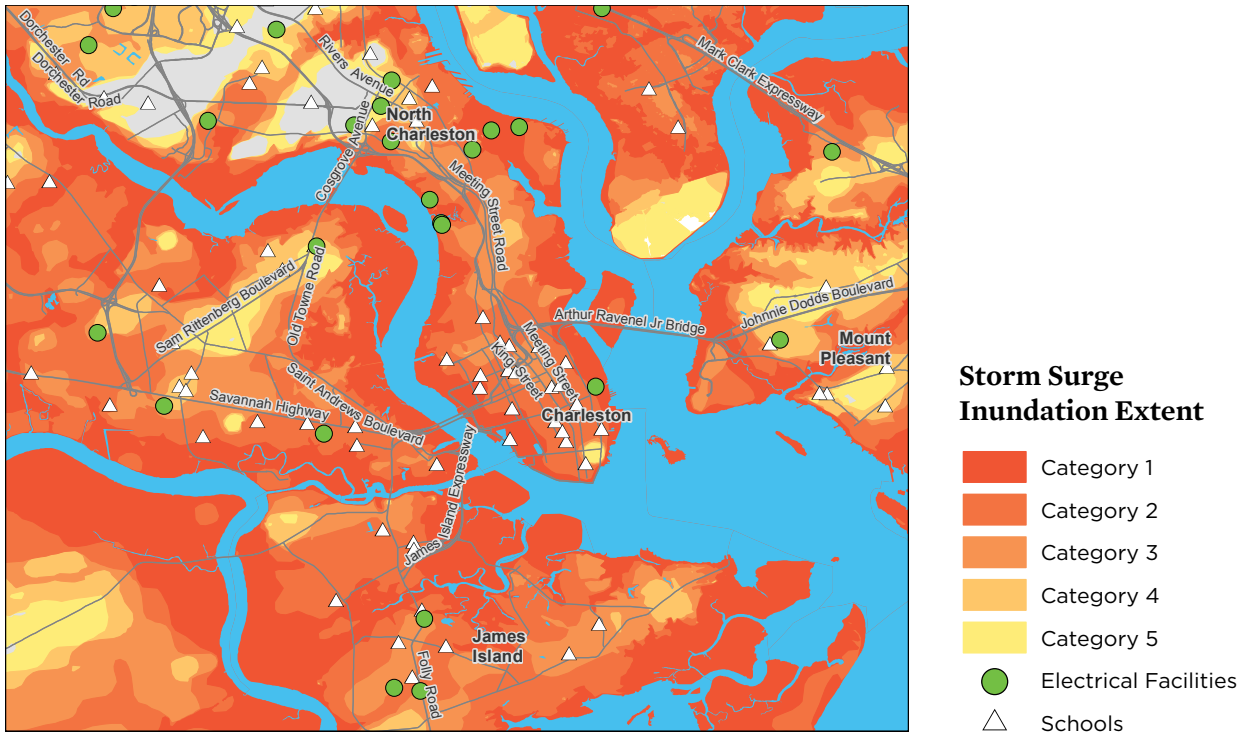
Charleston, SC, sitting at the confluence of three rivers, is extremely vulnerable to hurricanes, sea level rise, and accompanying increases in tidal flooding (Holtz et al. 2014). The last major hurricane to hit Charleston—Hurricane Hugo in 1989—devastated the city. However, it may not take another Category 4 hurricane to wreak similar destruction. The city is projected to experience 5.2 inches of sea level rise by 2030 and 11.5 inches by 2045 under a mid-range sea level rise scenario (Climate Central 2015). Tidal flooding, which currently happens an average of 24 times per year, is projected to increase to nearly 80 times per year by 2030 under a mid-range scenario and to more than 180 times per year by 2045 (Spanger-Siegfried, Fitzpatrick, and Dahl 2014).

The city of Charleston has a long, complex history. It is the oldest city in South Carolina, founded by English colonists in 1670. Built with the labor of enslaved Africans, it grew as a seaport and agricultural center with rice, cotton, and indigo plantations. During the Civil War, Charleston sustained significant damage and only slowly recovered, repairing its buildings rather than replacing them—thus beginning a tradition of historic preservation of antebellum buildings (City of Charleston 2015).

In contrast to its success in architectural preservation, Charleston struggles with gentrification and segregation. After the Civil War, the city was relatively integrated; freedmen stayed on in the areas that were once plantations. However, integration did not last. Following national trends, starting in the mid-twentieth century, "white flight" resulted in 30 years of steady out-migration by European American residents, creating a majority African American city in the 1980s. More recently, that trend reversed. Downtown neighborhoods have been revitalized, and college students increasingly vie for limited housing. Many African American Charleston natives describe being forced out because of prohibitive costs and the incentive to sell their homes as prices rose, resulting in a 55 percent drop in the African American population over 30 years (Kimpson 2015; Slade and Parker 2014). In contrast, northern parts of Charleston, where industrial, port, and rail activity fill the air with pollution, have remained predominantly African American (Gilliard 2015; Svendsen et al. 2014).

Charleston is at risk from hurricanes, sea level rise, and accompanying increases in tidal flooding. The city's historic Battery, a defensive sea wall and promenade, is vulnerable to major storms. Tidal flooding is routine today and projected to worsen as sea levels rise.

FIGURE 13. Charleston, SC: Present-day Exposure to Storm Surge from Different Categories of Hurricanes



In the past 35 years, four hurricanes have made landfall along the South Carolina coast (NWS 2013). These storms have ranged from relatively moderate Category 1 storms—such as Hurricane Gaston in 2004—to more severe storms, such as Hurricane Hugo, which struck the state as a Category 4 hurricane in 1989. Our analysis shows that even Category 1 storms have the potential to inundate broad swaths of the Charleston County coastline, particularly in low lying areas such as James Island. As was the case with Hurricane Hugo, the surge from Category 4 (or 5) storms can cause extensive damage to the city of Charleston, where the county's schools are most concentrated. With rising seas, future storm surges will reach farther inland. In addition, warming oceans are expected to contribute to more intense hurricanes.

SOURCE: UCS ANALYSIS USING NOAA'S STORM SURGE MODEL (SLOSH, AT *WWW.NHC.NOAA.GOV/SURGE/SLOSH.PHP*)

STORM SURGE FLOODING

The climate story in Charleston reflects not only its past, but also ongoing efforts to keep flooding at bay. Downtown Charleston and the adjacent city of North Charleston sit on a peninsula, which was widened artificially by filling in creeks and draining marshes. Many natural flood-control features were filled in with trash or diverted through pipes, reducing the peninsula's resilience to sea level rise and flooding (Thompson 2015). When category 4 Hurricane Hugo hit in 1989, winds of up to 130 miles per hour and storm surge caused a record-breaking $7 billion in damage (U.S. Department of Commerce and NOAA 2015). In an act of resilience, Charleston rebuilt after the storm, repairing and restoring historic homes. In fact, the city saw a boom in tourism from the revitalization efforts and today is one of the top travel destinations in the United States (Wise 2013).

Despite this, flooding during routine high tides is now a common occurrence. A recent study looking at increases in nuisance flooding in U.S. cities ranked Charleston as the city seeing the seventh largest increases over the last half century (Sweet et al. 2014). One in six homes in the city of Charleston lie less than four feet above the high-tide line, constituting a flood-damage risk of more than $4 billion (Strauss, Tebaldi, and Kulp 2014). Charleston has made some infrastructure improvements to protect against flooding and inundation, including improvements to some drainage systems and existing stormwater pumps and the installation of new ones, but more needs to be done (NOAA 2015).

UNEVEN IMPACTS

Ultimately, the entire peninsula will be affected by coastal climate impacts, but the impacts likely will not be felt evenly by all residents. In a recent interview, Katie Zimmerman of the South Carolina Coastal Conservation League explained that the eastern half of the peninsula experiences more tidal flooding that inundates homes and causes damage. She attributed this to decision makers' failure to prioritize climate adaptation, but commented that "[poorer] residents are less important to decision makers" (Zimmerman 2015).[45]

Elderly African American residents are among those most vulnerable in a major storm. Increasingly, the elderly residents in low-income, majority African American neighborhoods are the only remaining long-standing community members because their children are moving farther away as they are priced out (Lecque 2015). When a storm hits, these older residents may be isolated from their families (Allen and Allen 2015; Lecque 2015). Community leaders speak of the need to preserve diversity in the peninsula and to protect communities from displacement, but protecting vulnerable residents from climate impacts has not yet become a priority for policy makers (Gilliard 2015). Additionally, business interests, with their promises of economic benefits, seem to hold sway in local politics. In the WestEdge district and in North Charleston, for example, buildings are going up in former wetlands (Lecque 2015). The developers have failed to see wetlands as a natural ecological feature that could provide a buffer against storm surge and tidal flooding and instead hope to control flooding through landfill (Behre 2015). And as Charleston builds new roads and renovates flood-prone highways, in some cases communities have been displaced (Gilliard 2015).

State Senator Marlon Kimpson and State Representative Wendell Gilliard explained in an interview that there have not been material efforts to address climate change in the State General Assembly (Gilliard 2015; Kimpson 2015). Gilliard also argued that a more cohesive city- or county-wide effort to address the impacts of climate change on communities of color is needed (Gilliard 2015).But despite the lack of political salience of these topics, there are ways to move forward. South Carolina already has laws protecting marsh land, which can provide a natural buffer and flood control (Zimmerman 2015). While Charleston's peninsula has none of its original salt marshes left, these laws could be more effectively used to leverage natural systems for flood control. Subsidized housing and other community development projects could also integrate initiatives aimed at natural flood control (Zimmerman 2015).

Charleston has rebounded before, and it may be able to rebound again. But it will need to do more to protect its residents from future storms. If Charleston faces another Hugo, there is a high potential that the Battery, an iconic defensive seawall, will be breached by floodwaters, causing major damage (Maland 2015). Even without a hurricane, Charleston's residents are experiencing an increase in tidal flooding due to sea level rise, and Charleston needs to prioritize the needs of its most at-risk residents. Otherwise, the coming damage will only compound existing inequalities.

Opa-locka and Hialeah: Two Florida Communities Grappling with Decades of Storm Impacts

WRITTEN BY NICOLE HERNANDEZ-HAMMER

The neighboring cities of Opa-locka and Hialeah, located in the western corner of Miami-Dade County, FL, are low-lying with an average elevation of approximately six feet (Jacobsen, Macmillan, and Pinto 2015). Like most of southeast Florida, Hialeah and Opa-locka sit on a very porous limestone (USGS 2010). This limestone holds fresh water (the Biscayne aquifer) and is the source of potable water for most of the region (Miami-Dade 2012). As sea levels rise, the water table also rises, bringing the potential to contaminate wells and contribute to inland flooding (Weissman 2015). Projected sea level rise for southeast Florida by 2060 is 9 to 24 inches (Southeast Florida Regional Climate Change Compact 2011). The eight inches of sea level rise that has occurred over the last 100 years in Florida is already causing sunny-day flooding during seasonal high tides (Florida Oceans and Coastal Council 2010), and higher sea levels will continue to amplify the storm surges of hurricanes and tropical storms (Strauss, Tebaldi, and Ziemlinksi 2012).

Both Opa-locka and Hialeah are low-income communities: though Hialeah has an active and productive business sector, the median household income is only $29,961 (compared to the U.S. median of $53,046), while the median household income in Opa-locka is $20,338. Both cities have majority minority populations. Opa-locka's population of 15,967 is 66 percent African American and 35 percent Hispanic, while Hialeah's population of 233,394 is approximately 95 percent Hispanic and 3 percent African American (U.S. Census Bureau 2010). A 2010 report referred to Opa-locka as a "thriving food desert," an environment "that supports substandard nutritional outposts" (War on Poverty 2010). Hialeah's high unemployment rate, coupled with the fact that most adults lack health insurance, contributes to the ongoing economic struggle of its residents (Munzenreider 2012). These issues complicate and increase the need for resiliency efforts.

Current climatic changes add a greater sense of urgency to the on-going efforts to address poverty. A 2012 report from the Opa-locka Community Development Corporation identified key strategies for strengthening the city's economy such as more workforce development initiatives and the designation and preservation of historic buildings and homes (Reese Fayde 2012). These recommendations both allow for economic development and, if implemented thoughtfully, could make the city significantly more resilient through green jobs and projects, and storm-ready infrastructure upgrades.

The critical need for resilience in Miami-Dade's low-income communities was most evident during Hurricane Wilma in 2005, which amplified the destruction caused by Hurricane Katrina just weeks before (South Florida Sun-Sentinel 2015). Katrina hit south Florida as a category 1 storm before making landfall in the Gulf Coast as a category 3 storm (CNN 2005; NOAA 2005). Hurricane Wilma reached south Florida as a category 3 storm with winds of 125 miles per hour and a storm surge of seven feet (South Florida Sun-Sentinel 2015; Harrington and Walton 2008; Kaspar 2007).

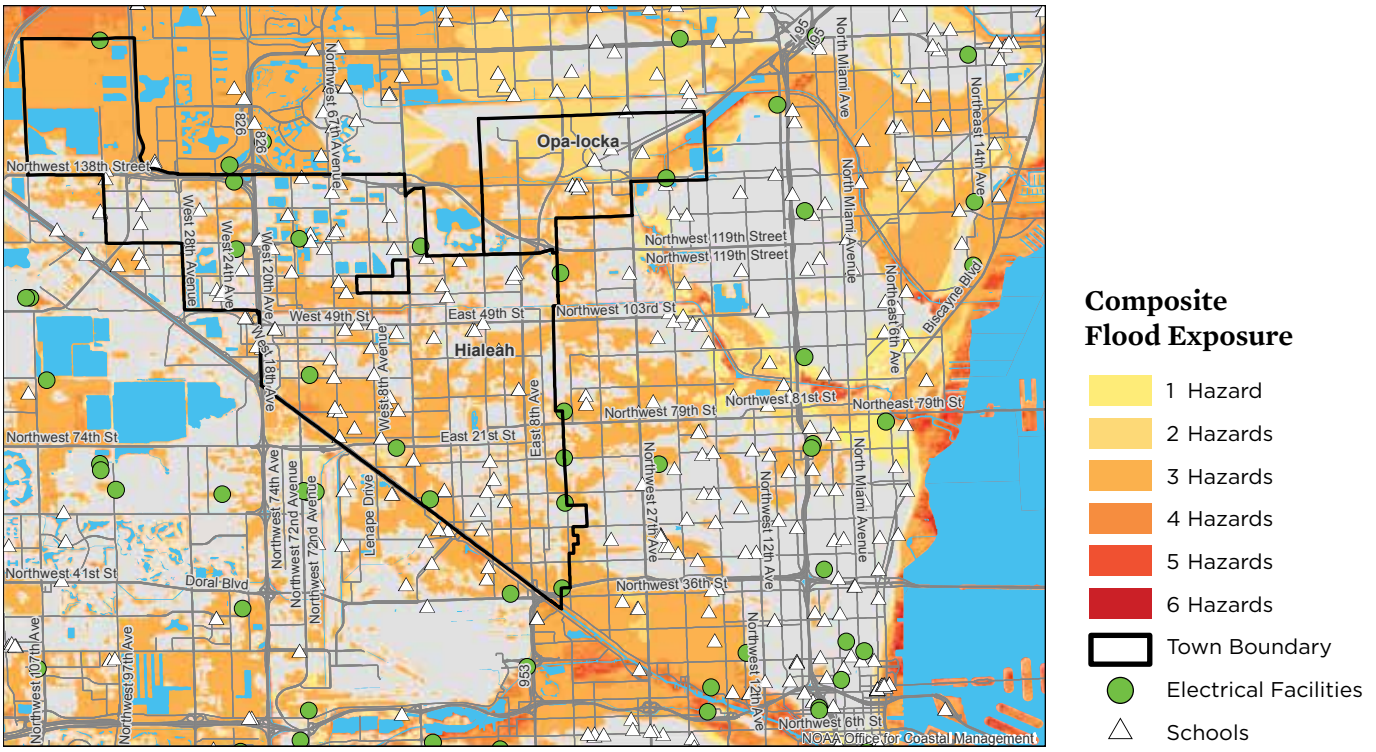
Local resident Christie Diaz was a teenager living with her parents in Hialeah when Hurricane Wilma hit her neighborhood. She remembers her apartment building being without power for two weeks, and government food trucks made deliveries to the community. Her parents were unable to get to work for several weeks, and she was out of school for nearly a month; but, she noted, it was the elderly living in multi-family buildings who had the hardest time receiving assistance.

Diaz noted how streets now regularly flood during routine rainstorms, and this flooding lasts longer than it did 10 or 15 years ago. She says: "Everybody should know about how sea level rise is affecting our community, because it is affecting us now and will be even worse in the future. If we don't know, we can't take action" (Diaz 2015).

Gilberto Turcios is a long-time resident of Opa-locka and was there during the relentless 2005 hurricane season. He recalls trees falling on homes, including his aunt's, and roots pulling up sewer pipes. He remembers long lines of residents waiting for water, food, and supplies from FEMA,

Much of southeast Florida is low-lying, with bedrock of porous limestone. As sea levels rise, tides are now riding on elevated water levels and the water table also rises, contributing to inland flooding.

FIGURE 14. Flood Risk in Miami-Dade County from Storm Surge and Other Factors



Hurricane-induced storm surge is only one of several types of flooding that can place communities at risk. Heavy rainfall, for example, is a common cause of flooding during hurricanes as well as weaker storms. South Florida is underlain by the Biscayne aquifer in which groundwater is very close to the surface. So when heavy rain falls, the ground is quickly saturated and the land readily floods. This is all the more true when rainfall and storm surge combine during a hurricane. This map shows Composite Flood Exposure, an index developed by the NOAA Office of Coastal Management to show how many flood hazard zones a given location falls within. The index factors in flood risk from shallow coastal flooding, high- and moderate-risk flooding determined by FEMA, Category 3 hurricane storm surge, and sea level rise of 3 feet. Darker colors indicate more flood hazard zones for that location. In Hialeah and Opa-locka, heavy rains present a greater flood risk than storm surge.

DATA SOURCES: NOAA OFFICE OF COASTAL MANAGEMENT

the Red Cross, foreign embassies, and other organizations, but he feels that the local churches were most involved in giving aid to Opa-locka's residents. He says that although the information residents received about the coming storms was helpful, there was not enough transportation available to residents who wanted to evacuate.

Turcios felt that government agencies failed low-income communities after the storm. Agency personnel promised to repair damaged roofs, but supplied temporary blue tarps and provided no follow-up services. In Turcios' view, "the government didn't do the right thing in poor communities; they just did a quick fix and forgot about it." He felt that because of climate change, preparing the community and having a plan for recovery is more important now than ever: "Over the last 20 years I've noticed flooding happening more often … I'm concerned because the more water tends to be around a home the more the water can crack the walls and weaken the base of the house. It's an economic loss, it hurts property values … Raising a house is very expensive, and only three or so homes have been elevated in my neighborhood" (Turcios 2015).

As local governments and federal agencies move forward with projects to revitalize Opa-locka's and Hialeah's economies, resilience should be a key driver behind these efforts in order to allow for progress even in the face of climate change (City of Opa-locka 2014; Carras Community Investment and Urban Revitalization Solutions 2011).

Gulfport, MS: A Struggle Against Flooding and Environmental Injustice

CO-WRITTEN BY RACHEL CLEETUS AND SARAH PENDERGAST

The sprawling city of Gulfport is located in Harrison County, MS, along the Gulf of Mexico. With scenic beaches, resorts, casinos, and golf courses, the area is a hub of tourism. Hurricanes, storm surge, and inland flooding have long plagued the Mississippi shoreline, but the devastation of Hurricanes Katrina and Rita in 2005 caused unprecedented, long-lasting damage, and uneven recovery. Between 1985 and 2014, Harrison County suffered nearly $6 billion in property and crop damages from coastal storms, hurricanes, and flooding (in 2014 dollars) (Hazards and Vulnerability Research Institute 2015). And with rising sea levels, the risks of coastal flooding and storm surge are worsening.

Other local factors, including land subsidence along the Gulf Coast combined with accelerating sea level rise due to climate change, will lead to a projected increase in local sea level of an additional 19 inches by 2050 (Climate Central 2012). Simultaneously, the rapid loss of coastal wetlands to growing development is reducing natural protections against flooding and worsening its impacts.

Hurricane Katrina devastated portions of the Mississippi coast with storm surge flooding of 25 to 28 feet above normal tide level and with flood waters reaching more than six miles inland (NOAA 2006). In the aftermath of the hurricane, disaster aid was slower to arrive in communities of color, such as North Gulfport and Turkey Creek, exacerbating existing stresses on these neighborhoods (Crowley and Johnson 2005). Affordable housing units in Harrison County, in short supply prior to the storm, declined by 25 percent due to Katrina (McCarthy and Hanson 2008). Higher rents for the remaining units and a greater emphasis on repairing single-family owner-occupied homes relative to multi-family rental units further reduced the affordable housing stock.

FEMA

An aerial shot of Gulfport, MS, after Hurricane Katrina, showing houses completely removed from their foundations and destroyed.

Explaining the situation in a 2007 interview, Melinda Harthcock of the Steps Coalition said, "We had an affordable housing crisis before the storm. Developers were filling in wetlands … but few noticed the danger. Katrina dramatically accelerated everything" (PBS 2007). Kathy Egland of Gulfport, chair of the NAACP Environmental and Climate Justice Committee, warns that "people need to understand that when, not if, the next storm comes it will be even worse. Now when we have hard rain, we have flooding we hadn't experienced before" (Egland 2015).

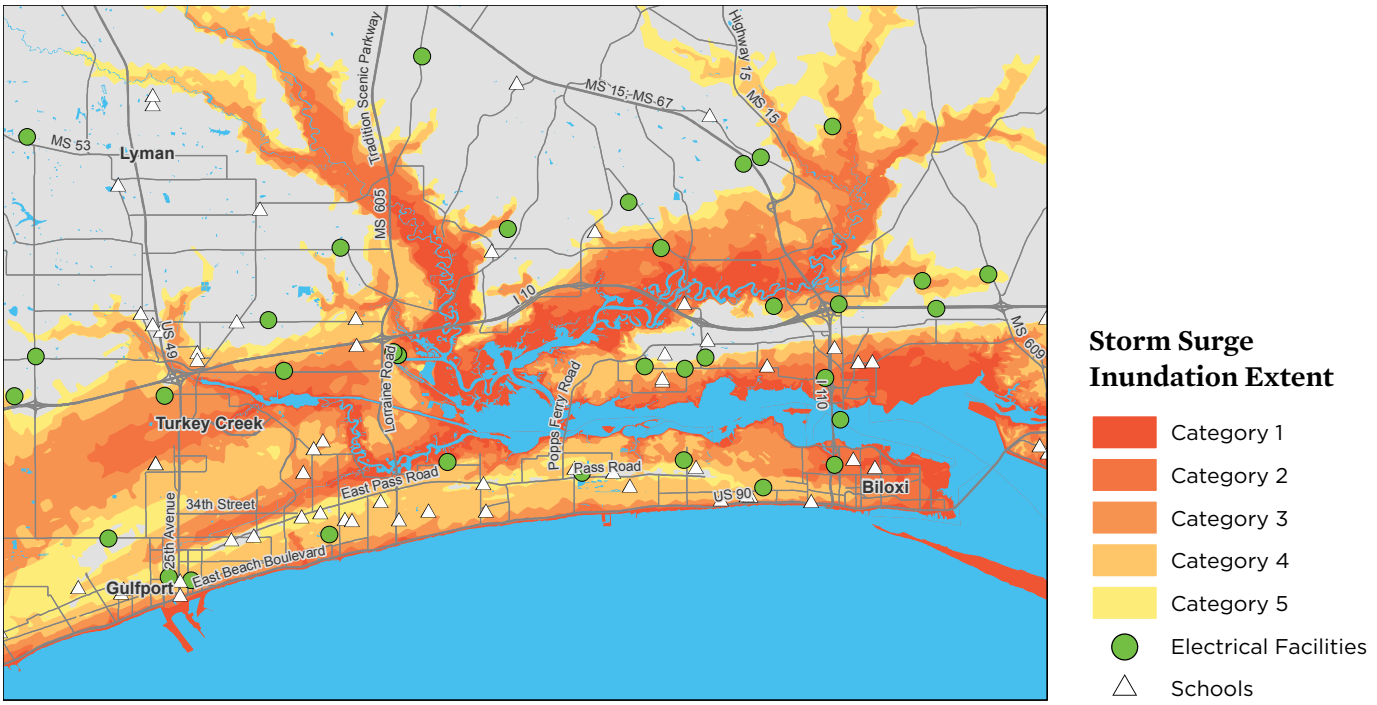
IMPACTS ON THE TURKEY CREEK COMMUNITY

Settlement patterns in the Gulfport area reflect the area's long history. In 1866, African American freedmen and women settled there in swampland areas, such as Turkey Creek and North Gulfport, and were banned from beaches and areas along the coast where the white population lived. In 2001, the Turkey Creek community was recognized as one of the 10 most endangered historic places in Mississippi and was added to the National Register of Historic Places in 2007. Today, more than 36 percent of Gulfport's population is African American, and nearly one-quarter of the overall population lives in poverty. Sprawling development to the north of the city has put pressure on wetlands as they get dredged and filled (Whitehurst 2013), and this has disproportionately increased the flooding risk borne by low-income African American communities (Zaitchick 2015).

According to Derrick Evans of Turkey Creek, "Gulfport is a giant textbook of incompatible land use"(Zaitchick 2015). But, he says, "The Turkey Creek watershed is very important. … [We need to] get the wetlands off the development table. We are working to get our fair share of RESTORE Act [Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act] dollars." (Evans 2015). Howard Page of the Steps Coalition agrees: "A healthier wetland only adds to flood protection" (Page 2015).

Gulf Coast residents have worked hard to protect and revitalize their communities in the wake of Hurricanes Katrina, Rita, and Isaac, and the BP Deepwater Horizon oil spill, working through organizations such as the North Gulfport Community Land Trust, the NAACP, the Steps Coalition,

FIGURE 15. Gulfport, MS: Present-day Exposure to Storm Surge from Different Categories of Hurricanes



Owing to its Gulf Coast location, Harrison County, MS, has experienced hurricanes throughout its history, including Category 5 Camille in 1969 and Category 3 Katrina in 2005. While the area potentially affected by surge from Category 1 storms is relatively limited and includes few schools or electrical facilities, Category 3 storms, such as Hurricane Katrina, have the potential for widespread damage. Katrina, for example, brought more than ten feet of water to the streets of Gulfport and left more than one million Mississippians affected. With rising seas and land subsidence, future storm surges will reach farther inland. In addition, warming oceans are expected to contribute to more intense hurricanes.

SOURCE: UCS ANALYSIS USING NOAA'S STORM SURGE MODEL (SLOSH, AT *WWW.NHC.NOAA.GOV/SURGE/SLOSH.PHP*)

the Sierra Club, the Audubon Society, the Gulf Coast Fund, the Mississippi Coalition for Vietnamese-American Fisher Folks and Families, the Gulf Restoration Network, and the umbrella regional movement Gulf South Rising. Their efforts contributed to the decision by Southern Company to convert the nearby Jack Watson power plant from burning coal to burning natural gas. Fishing communities are trying to rebuild livelihoods after impacts such as the steep drop in oyster dock landings over the last decade (Governor's Oyster Council 2015). The groups are also calling on state and local officials to include their perspectives in both planning and allocating funding awarded as a result of the Deepwater Horizon disaster (Sturgis and Kromm 2012).

Community engagement must account for diverse needs, for example, translation services. Thao Vu, executive director of Mississippi Coalition for Vietnamese-American Fisher Folks and Families, says, "When Hurricane Katrina came, it didn't just damage housing, but also fishing infrastructure. So, not just their homes, but also their livelihoods [were affected], and future disasters [will] only exacerbate [the] losses and impacts they've experienced. FEMA aid centers set up after Katrina did not have adequate translators or materials written in a manner people [could] understand. Title VI of the Civil Rights Act and executive order[s] should address diversity of language in the community, but we do not have a model of compliance here in Mississippi" (Vu 2015).

Plaquemines Parish, LA: Sinking Land and Rising Seas Mean Tough Choices

WRITTEN BY RACHEL CLEETUS

Plaquemines Parish, much of which lies below sea level, is located to the southeast of New Orleans where the Mississippi river flows into the Gulf of Mexico. Despite an extensive levee system surrounding portions of the parish and plans for more investments in flood control, coastal communities face a difficult future with growing threats from flooding and storm surge.

Louisiana is experiencing some of the highest rates of relative sea level rise in the world (NOAA 2013a). Land subsidence—caused by upstream flood-control measures on the Mississippi River, oil and gas operations, and sediment compaction—is a major contributor. Wetlands that once helped shield the coast from being battered by storms are now being lost at a rate of 40 square miles per year, with 2,300 square miles of wetlands (an area larger than Delaware) having been lost since 1932 (Plaquemines Parish government 2015; Rich 2014). According to the state of Louisiana, its coasts could see 10.6 to 31.5 inches of sea level rise between 2010 and 2060, which will result in significant coastal land loss, including in Plaquemines (Melillo, Richmond, and Yohe 2014).

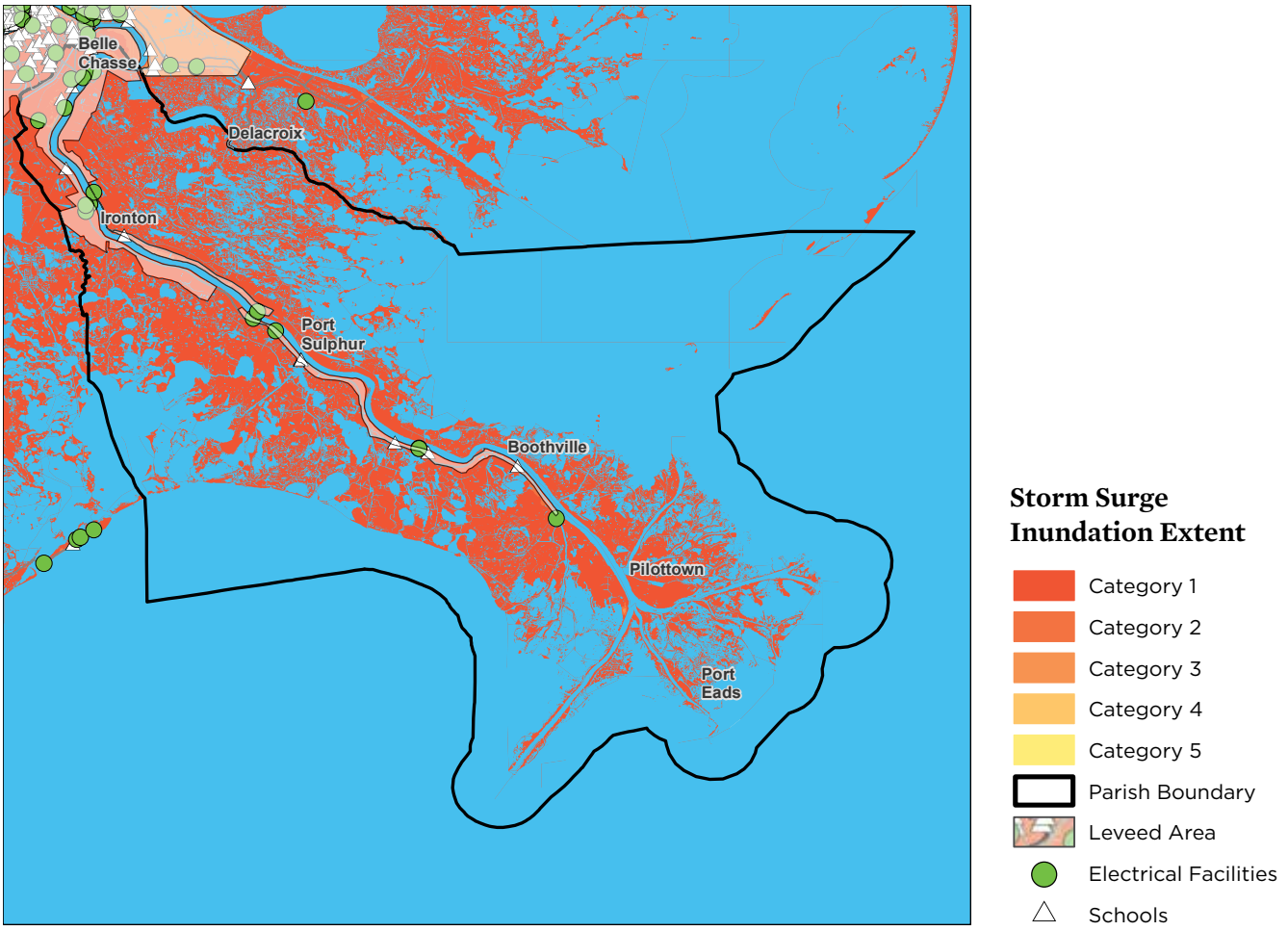
Several predominantly African American communities located in Plaquemines are ground zero for the harsh confluence of socioeconomic vulnerability and extreme risks from sea level rise. Formerly the sites of plantations, the communities of Ironton, St. Rosalie Plantation, Woodland, and many other towns were established by formerly enslaved people whose descendants live there today. Faced with segregation and discriminatory laws, the Plaquemines African American community engaged in a civil rights struggle that resonates to this day.

Today residents live with significant pollution from nearby oil refineries and coal export terminals (Alexander-Bloch 2013; Buchanan 2012).[46,47] The 2010 Deepwater Horizon oil rig explosion occurred just 40 miles from the coast of Plaquemines Parish, and the consequent oil spill affected more than 3,000 acres of coastal wetlands in the parish and devastated the livelihoods of many people in the local African American fishing community (Kamat 2010; Nungesser 2010).

Andrea Booher/FEMA

Residents of Plaquemines Parish talk with a FEMA representative outside of their flooded home following Hurricane Katrina.

FIGURE 16. Plaquemines Parish, LA: Present-day Exposure to Storm Surge from Different Categories of Hurricanes



When Hurricane Katrina made landfall as a Category 3 storm in Louisiana in August of 2005, it did so in Plaquemines Parish. While media attention during and after the storm focused primarily on New Orleans, just to the northwest, the smaller towns of Plaquemines Parish were devastated by a storm surge of approximately 12 feet. Unlike New Orleans, many of the towns of Plaquemines are largely unprotected by levees and are therefore vulnerable to complete inundation with only a Category 1 storm, as this map shows. The parish is home to over 23,000 people.

SOURCE: UCS ANALYSIS USING NOAA'S STORM SURGE MODEL (SLOSH, AT *WWW.NHC.NOAA.GOV/SURGE/SLOSH.PHP*)

Hurricane Katrina made landfall in the town of Buras in Plaquemines Parish, and the parish was hit again by Hurricanes Rita in 2005 and Isaac in 2012. In addition to the death and devastation caused by Katrina, coastal towns in Plaquemines Parish lost between 40 and 70 percent of their residents to displacement (Krupa 2011).[48] Despite federal government disaster assistance of nearly $20 billion to Louisiana, in the wake of Katrina and Rita, residents in smaller coastal communities like those in Plaquemines have had difficulty accessing the aid and are still struggling to rebuild (FEMA 2015; Kamat 2010).

The state of Louisiana's 2012 Comprehensive Master Plan for a Sustainable Coast, developed in partnership with the U.S. Army Corps of Engineers, is an ambitious attempt to stave off threats to this coastally dependent state by investing in ecosystem-based defenses, like barrier islands and wetlands, alongside human-made defenses like levees (State of Louisiana 2012a). The centerpiece of the $50 billion, 50-year plan, the Mid-Barataria Sediment Diversion, is designed to replenish sediment in the Mississippi delta to help build and maintain land and protect coastal wetlands. This and other aspects of the plan, however, are controversial. Some

scientists estimate that land loss will outpace the effectiveness of the diversion and believe that the 2012 iteration of the plan used inadequate projections of sea level rise. Others worry that it could leave some communities unprotected (Marshall 2015; Blum and Roberts 2009). Ironically, the BP oil spill has renewed focus on the need to invest in coastal protection and restoration, and the damage settlement reached with BP could provide a source of funding for this effort.

The reality is that severe risks from sea level rise, past decisions that have undermined natural coastal barriers, and the inevitable limits of engineering solutions, mean that many communities in coastal Louisiana face very tough choices. The challenge will be finding equitable ways forward that give these communities a voice in the process and marshal the resources they need to make those choices. Community members are building alliances for a better vision for the future, with the ongoing support of groups including the Gulf Restoration Network, the Gulf South Rising movement, and the Sierra Club.

Reverend Tyrone Edwards, pastor of the Phoenix Zion Travelers Baptist Church, speaks to new opportunities to get this right.

> *We found out that disasters and coastal restoration are big money. It's more about giving contracts to some people than protecting [Louisianans/people in Plaquemines Parish]. Oftentimes, the work is overpriced [and too much spent on overhead and subcontracts]. If more of the money were used correctly, we could have more projects done.*
>
> *. . . It is key that local people are employed in the coastal restoration projects. That's one way to work towards making communities whole.* (Edwards 2015)

Several predominantly African American communities located in Plaquemines are ground zero for the harsh confluence of socioeconomic vulnerability and extreme risks from sea level rise.

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[ENDNOTES]

1 *Local groups made the case that then-Governor Hayley Barbour's decision to direct $600 million of federal disaster recovery funds toward commercial infrastructure projects, including building a port, rather than on rebuilding homes was unlawful. The state justified the choice on the grounds that the port would spur economic opportunities and jobs. In 2010 the groups reached a settlement with HUD and the governor's office that resulted in the allocation of $133 million to address the housing needs of poor residents. The governor's initial recovery plan also barred access to the disaster funds to renters and low-income homeowners whose homes were damaged but who did not have flood insurance—either because they lived outside the floodplain and were not required to purchase insurance or because they had been unable to afford insurance (Gotham 2014; Robertson 2010; Morse 2008; Eaton 2007).*

2 *Low-income communities and communities of color also face disproportionate impacts from other climate impacts such as heat waves, droughts, and wildfires, and from climate impacts on major sources of employment such as agriculture and tourism (Shonkoff et al. 2011).*

3 *Louisiana parishes and Baltimore City are both considered to be county-equivalents and are represented by the term "counties" in this report.*

4 *Dr. Bullard's comment was made at the NAACP-UCS Climate Equity Convening held on November 13, 2014 (see Box 3, p. 8).*

5 *Ruth Story's comment was made at the NAACP-UCS Climate Equity Convening held on November 13, 2014 (see Box 3, p. 8).*

6 *The 2014 IPCC AR5 report, Summary for Policy Makers, notes the following: "Differences in vulnerability and exposure arise from non-climatic factors and from multidimensional inequalities often produced by uneven development processes (very high confidence). These differences shape differential risks from climate change. People who are socially, economically, culturally, politically, institutionally, or otherwise marginalized are especially vulnerable to climate change and also to some adaptation and mitigation responses (medium evidence, high agreement). This heightened vulnerability is rarely due to a single cause. Rather, it is the product of intersecting social processes that result in inequalities in socioeconomic status and income, as well as in exposure. Such social processes include, for example, discrimination on the basis of gender, class, ethnicity, age, and (dis)ability" (IPCC 2014a).*

7 *Ibid. "Climate-related hazards exacerbate other stressors, often with negative outcomes for livelihoods, especially for people living in poverty (high confidence)."*

8 *As the National Climate Assessment states, "climate change impacts add to the cumulative stresses currently faced by vulnerable populations" (Melillo, Richmond, and Yohe 2014). These stresses can include poverty, ill health, and disenfranchisement.*

9 *The data from these studies show that low-income households, people who rent, the elderly, and people who lived in public housing were disproportionately affected by the storm. In response to this information, the NAACP Legal Defense and Educational Fund, Inc., National Fair Housing Alliance, and Poverty and Race Research Action Council filed suit against FEMA. On May 30, 2014, HUD announced a settlement in a fair housing complaint filed against the state of New Jersey by the Latino Action Network, the New Jersey NAACP, and the Fair Share Housing Center. The complaint alleged that the state's use of Superstorm Sandy federal disaster recovery funds involved discriminatory housing practices.*

10 *One particularly destructive practice embraced by administrations during much of the twentieth century was failing to withhold HUD funding from communities that continued to maintain housing segregation. The government lost an opportunity to use the considerable leverage of this funding to ensure fair housing practices, and its failure to do so was a deliberate capitulation to segregationist interests (Hannah-Jones 2015). Another practice was the openly discriminatory policies of the Home Owners Loan Corporation, which was set up to make decisions about which neighborhoods would be eligible for loans from the Federal Housing Administration. The Home Owners Loan Corporation fostered a discriminatory policy of mortgage "redlining" for communities with minority or immigrant populations, deeming these areas unsafe and their residents not creditworthy (Coates 2014). The Obama Administration recently announced that it will more assertively enforce the provisions of the Fair Housing Act of 1968 and require cities and towns that make use of HUD funding to meet their obligations under the law (HUD 2015). Although a welcome step, it is also a sign of how slowly change comes even decades after laws are passed.*

11 *Many historically African American neighborhoods in major cities, in particular, remain heavily isolated, even as historically white neighborhoods are becoming increasingly multi-racial and multi-ethnic. Census data show that major cities where a majority of blacks still live in racial isolation include Atlanta, Baltimore, Detroit, Philadelphia, St. Louis, and our nation's capital, Washington, DC. (Hannah-Jones 2015; De la Roca, Ellen, and O'Regan 2014; Keating 2014; Sharkey 2013).*

12 *Neighborhoods that are disadvantaged to begin with are less likely to attract new investment, creating a cycle of deterioration.*

13 *Vernice Miller-Travis' comment was made at the NAACP-UCS Climate Equity Convening held on November 13, 2014 (see Box 3, p. 8).*

14 *Lisa Garcia's comment was made at the NAACP-UCS Climate Equity Convening held on November 13, 2014 (see Box 3, p. 8).*

15 *While there are complex reasons for the persistence of these gaps, their origin lies in various forms of discrimination—and in the case of African Americans, slavery and segregation.*

16 *See* www.census.gov/content/dam/Census/library/publications/2014/demo/p60-249.pdf; www.nytimes.com/2014/08/20/upshot/americas-racial-divide-charted.html?abt=0002&abg=0; *and* www.pewresearch.org/fact-tank/2014/12/12/racial-wealth-gaps-great-recession.

17 *More than 38 percent of African American children and more than 30 percent of Hispanic children live in poverty, compared with approximately 11 percent of white children (DeNavas-Walt and Proctor 2014). See Table B-2 in* www.census.gov/content/dam/Census/library/publications/2014/demo/p60-249.pdf.

18 *In 2010, approximately 40 percent of Hispanic adults and approximately 25 percent of African American adults had no health insurance. These statistics are changing because of the implementation of the 2010 Affordable Care Act.*

19 *As defined by the EPA: "Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. EPA has this goal for all communities and persons across the nation. It will be achieved when everyone enjoys the same degree of protection from environmental and health hazards and equal access to the decision-making process to have a healthy environment in which to live, learn, and work." See* www3.epa.gov/environmentaljustice.

20 *Title VI of the Civil Rights Act holds that "no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance."*

21 *The latest updates to the index and underlying data are available at the website for the Socioeconomic Vulnerability Index (SoVI):* http://webra.cas.sc.edu/hvri/products/sovi.aspx.

22 *For 10 of the counties we did not have tidal flooding projections because of a lack of local tide gauge data. For those counties the sea level rise projections made up the full climate risk indicator.*

23 *In other words, the normalization equation was: (x – min) / (max – min), where x is the variable being normalized.*

24 *The U.S. Census's QuickFacts data are derived from a number of census data sets: Population Estimates, American Community Survey, Census of Population and Housing, Current Population Survey, Small Area Health Insurance Estimates, Small Area Income and Poverty Estimates, State and County*

Housing Unit Estimates, County Business Patterns, Nonemployer Statistics, Economic Census, Survey of Business Owners, and Building Permits.

25 *The four variables we chose are familiar and widely available statistics that capture essential characteristics of a community and are commonly used in the literature: 1) per-capita income measured over the past 12 months, in 2013 dollars, 2) poverty rate expressed as the percentage of people living below the federal poverty rate, 3) education expressed as the percentage of people aged 25 or above with an educational attainment of less than a high school graduation, and 4) the percentage of minority population defined as the percentage of the population that is Hispanic or Latino, black or African American, Asian American, Native Hawaiian and other Pacific islander, and American Indian and Alaska Native. Other important measures of communities' resilience, which we were not able to include in our analysis, are quality of governance and access to basic services, health status, and the relative concentrations of very young and old persons, people with disabilities, and female-headed households with children.*

26 *Because of a lack of adequate NOAA tide gauge data, we do not have tidal flood data for 10 counties and parishes in the sample. This includes all counties in Louisiana and Mississippi (except Hancock County, MS), Lee and Indian River counties, FL, and Westmoreland County, VA.*

27 *These counties have the same climate risk indicator value, reflecting a common sea level rise projection for 2045 (19.4 inches). For most other counties the risk indicator also incorporates tidal flooding frequency projections that are locally distinct (but unavailable for 10 of the counties in the sample).*

28 *The per-capita income and poverty rate statistics come from the U. S. Census Bureau's American Community Survey and are not geographically adjusted for states and regions. (See* http://factfinder2.census.gov.*)*

29 *Maryland's Baltimore County is separate from, and largely surrounds, the city of Baltimore, a separate political unit considered similarly to county jurisdictions. The U.S. Census list of counties for Maryland includes Baltimore County and Baltimore City, and we analyzed both in this report.*

30 *See note 29.*

31 *Several counties that rank as highly vulnerable under the SoVI also rank high on our indicator, including the metro areas encompassing Philadelphia, Baltimore, and Miami, and Orleans Parish, LA. There is also a lot of commonality among counties that rank relatively low in vulnerability across both UCS and SoVI indicators, including York and Virginia Beach counties in Virginia, the Connecticut counties, and Monmouth and Ocean counties in New Jersey. A few counties stand out for ranking much differently in the SoVI. Louisiana's Plaquemines, St. Bernard, and Jefferson parishes rank much lower with the SoVI, as do Harrison County, MS, and Wicomico, MD. In contrast, Lee and Indian River counties in Florida; Lancaster County, VA; Atlantic County, NJ; and Kent County, MD; all show significantly higher vulnerability with the SoVI.*

32 *The Spatial Hazard Events and Losses Database for the United States (SHELDUS) was developed and is maintained at the University of South Carolina's Hazards and Vulnerability Research Institute. The SHELDUS dataset is hazard-based, unlike the National Climatic Data Center storm damages database, which is event-based. The SHELDUS dataset also includes a number of improvements that made it easier to evaluate county-level data more accurately for the purposes of this report. For more information see* http://hvri.geog.sc.edu/SHELDUS.

33 *We used data for four hazard categories identified in the database: coastal, flooding, hurricane/tropical storm, and wind. In addition to dollar damages, SHELDUS also has estimates of fatalities and injuries.*

34 *FEMA administers three Hazard Mitigation Assistance programs: the Hazard Mitigation Grant Program, the Pre-Disaster Mitigation program, and the Flood Mitigation Assistance program.*

35 *The Hazard Mitigation Grant Program is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (see* www.fema.gov/media-library/assets/documents/15271*). The Pre-Disaster Mitigation Grant Program, authorized under the Stafford Act and administered by FEMA, provides funds to states and tribal governments to help reduce the risks of losses from future disasters. In FY15, the National Pre-Disaster Mitigation Fund amounted to $30 million.*

36 *In July 2013 FEMA announced a memorandum of understanding with the NAACP "to ensure the needs of underrepresented communities are more fully incorporated into disaster preparedness, response, recovery and mitigation-related activities" (FEMA 2013). Ensuring that this memorandum of understanding is implemented and adequately resourced is critical.*

37 *A set-aside called the '5% Initiative' allows five percent of Hazard Mitigation Grant Program money to go to projects that cannot be easily evaluated using cost-benefit criteria, but this is completely inadequate to meet the needs of low-income communities and is not specifically targeted at them.*

38 *Funding for the HOME program has been cut significantly, from $1.8 billion to $900 million over the last five years. As recommended by the National Low Income Housing Coalition, this funding should be restored to at least $1.2 billion per year, with 30 percent of the funds targeted to extremely poor households (NLIHC 2015).*

39 *The study used a model developed by the EPA and collaborators called the sea level rise national coastal property model. The model assumes that if the cost of protective measures (such as building sea walls or beach nourishment) is less than the benefit of avoided property-value loss at a particular location, then protective measures will be employed. However, if the cost is greater than the avoided property-value loss, then the choice would be to retreat from or abandon the location.*

40 *Cyn Sarthou's comment was made at the NAACP-UCS Climate Equity Convening held on November 13, 2014 (see Box 3, p. 8).*

41 *For example, many groups in communities affected by Hurricane Katrina marked the 10th anniversary of the storm by committing to protect and revitalize their communities and to gain more decision-making power over development and restoration plans for the future. See* www.gulfsouthrising.org/.

42 *The phrase "40 acres and a mule" refers to an unfulfilled promise to formerly enslaved people that, upon their freedom, they would be granted ownership of 40 acres of land and a mule to begin their new lives. The policy was quickly overturned and the promised land, from Charleston, SC, to St. John's River, FL, remained by and large in the hands of plantation owners. For more information see* www.pbs.org/wnet/african-americans-many-rivers-to-cross/history/the-truth-behind-40-acres-and-a-mule.

43 *Queen Quet's comment was made at the NAACP-UCS Climate Equity Convening held on November 13, 2014 (see Box 3, p. 8).*

44 *During the April 15, 2007, Nor'easter, and the October 24–October 27, 2007 rain event, tide levels reached 3.5 feet, inundating numerous yards and roadways in Toddville, Bishops Head, Crocheron, Crapo, and Wingate, and across Elliott Island Road (MD DNR 2008).*

45 *For example, the city failed to repair one of the peninsula's two batteries, defensive seawalls that protect the city from storm surges. Only after a resident used the Freedom of Information Act to find out that the High Battery was not compliant with city code did the city take action. This resident was a lawyer who lives south of Broad Street—the city's wealthiest area—and credibly threatened to sue. Residents with fewer resources are less able to start and win battles like these to protect their communities (Zimmerman 2015).*

46 *Louisiana accounts for 20 percent of U.S. coal exports, much of it passing through terminals at the mouth of the Mississippi River* (www.nma.org/pdf/coal_export_report.pdf).

47 *A report from the EPA Office of the Inspector General ranks Louisiana as among the worst states nationwide in enforcing clean air, clean water and hazardous waste regulations.* www.epa.gov/oig/reports/2012/20111209-12-P-0113.pdf

48 *Katrina caused an estimated 1,833 deaths, 1,577 of which were in Louisiana, and displaced more than one million people in Gulf Coast states.*

Surviving and Thriving in the Face of Rising Seas

Building Resilience for Communities on the Front Lines of Climate Change

> ***Policy makers and agencies must ensure that investments in climate resilience are better targeted and more equitably shared, and communities on the front lines of climate change should have a direct voice in shaping their future.***

Coastal communities across the United States are facing worsening risks of flooding during routine high tides and damaging storm surges. With sea level rise accelerating along the East and Gulf Coasts, these problems are projected to intensify in the coming years, and they are likely to have a disproportionate impact on low-income and minority communities. This report is an attempt to guide improvements in policy making around disaster aid and preparedness to ensure that communities receive the support they need before and in the aftermath of climate-related disasters. It also makes the case for better long-term planning and sufficient resources to anticipate and prioritize the needs of frontline communities who bear the brunt of the climate impacts our nation is experiencing.

We present an analytical framework—a screening tool—to identify coastal "climate equity hotspots" that face heightened exposure to climate impacts because of a combination of climate and socioeconomic risk factors, and where additional attention and resources are required. We applied our screening tool using county-level data to assess the overlap of climate and socioeconomic risk factors for 35 coastal counties spread across nine East and Gulf Coast states.

If we fail to take action to protect frontline communities, the devastation and hardships they face today will be a reality for many more communities tomorrow. As a nation, we have to ensure that fairness and equity are an integral part of our climate solutions.

Union of Concerned Scientists

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